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ABSTRACT

Forty-four papers by 65 authors from the proceedings of a conference concerning issues in the emerging field of science, technology, and society education are included in this document. The papers are organized into three groupings: philosophical and research issues, underrepresented minorities in science and technology, and education from kindergarten through post-secondary and beyond. These groupings reflect the five themes of these recent conferences: education and information; technology, industry, and work; environment; health and bio-medicine; and moral, ethical, and philosophical perspectives. (DB)

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Technology Literacy V: Proceedings of the Fifth National Technological Literacy Conference

Arlington, Virginia

February 2-4, 1990

Edited by

Dennis W. Cheek

with a foreword by

Carolyn S. Graham

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These proceedings from the Fifth National Technological Literacy Conference (TLC-5) have been submitted to ERIC in an effort to make them widely available to educators and others interested in the emerging field of Science, Technology, and Society Education. (The proceedings will not be available elsewhere.)

There have now been five highly successful conferences, with the two most recent sponsored by the National Association for Science, Technology, and Society Education (NASTS),a fledgling organization committed to increasing communication and fostering dialogue among the many members of the STS community: scientists; engineers; philosophers; policy makers; religion professionals; public interest organizations; educators from elementary, secondary, post-secondary, and informal education institutions; and our international colleagues.

All of these diverse groups have much to contribute to the expansion of STS Education across the country and internationally. Thus I am pleased that forty-four papers by sixty-five authors appear in these proceedings. They are organized into three groupings: Philosophical and Research Issues, Underrepresented Minorities in Science and Technology, and Education from Kindergarten through Post-Secondary and Beyond. These groupings reflect the five themes of recent TLCs: Education and Information; Technology, Industry, and Work; Environment; Health and Bio-Medicine; and Moral, Ethical, and Philosophical Perspectives.

Just as TLC-5 (and the other TLCs) served as a forum where all participants could meet as equals to discuss, debate, and share concerns about our society's handling of science and technology, I hope that these proceedings will not only stimulate thought, discussion, debate, and concern, but also research and increased activity in STS Education.

It is with gratitude that the TLC-5 Program Committee acknowledges Dennis Cheek's fine efforts in preparing and editing these proceedings. Without his commitment, they would not be available.

I hope that your sampling of the papers presented here will whet your interest in STS Education, or will convince you that, if you are already interested in STS, you have something to contribute, both to future TLCs and to NASTS. A membership form for NASTS follows. Please join us in our quest for understanding of the complex interactions among science, technology, and society, and in our search for how best to educate our students to become productive and responsible citizens in this increasingly complex world of ours.

Carolyn S. Graham
Program Chair, TLC-5
and
President, NASTS, 1990

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Complete Conference Program

Philosophical and Research Issues

THE MYTH OF HIGH TECH SKILLS

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Over the past decade, a portrait of a bold new economic order has been laid out by corporate America, shaped by technological innovation and global competition, requiring new forms of management-labor cooperation and a sophisticated, highly skilled workforce. Based on this scenario, a new national enterprise in "human resource development," in education and training, is now in full swing.

There is scant critique of this enterprise, an enterprise which, for most observers, signifies that the interests of management, labor and education now all coincide. This is because the language used in corporate rhetoric is the same as that which has been used traditionally to describe labor's view of the ideal job and educators' ideal view of education, one which emphasizes the personal reward and challenge of lifelong learning, of mindful engagement, of thinking and problem-solving.

But the corporate call for "higher order," sophisticated, "high tech" skills really has little to do with worker empowerment or intellectual enhancement. Rather, it has to do with the opposite: further disempowerment and an erosion of critical understanding.

The argument here proceeds by way of an examination of the "sophisticated skills" claimed to be required of the new workforce. I show that this alleged "sophistication" amounts to two sorts of things: (1) dispositions and attitudes aligned with new corporate objectives, and (2) generic cognitive aptitudes adaptive to flexible new "high technology" production processes.

First of all, sophistication is that which somehow rubs off on a worker when he or she works with a sophisticated piece of technology. Harry Braverman (1974, p. 428), in **Labor and Monopoly Capital**, noted how the term "semiskilled" was invented in the 1930s with the stroke of a pen, when the director of the U.S. Census Bureau made the decision that anyone working all day with machinery would henceforth be considered not unskilled but, rather, "semiskilled." Suddenly, the minimal skills of a machine operative were more sophisticated than those of a farmer who had mastered a lifetime of skills required to run a farm. By now people who work with computers, too, are typically portrayed as having more sophisticated skills than those who do not. And jobs on automated machines are increasingly given higher ratings than those for conventional machines where the normal skill requirements are higher.

A related meaning of sophistication reflects the credential requirements of new jobs. Growing numbers of relatively low-skilled jobs require increasing levels of formal education credentials; a broadening range of low-skill factory assignments, for example, in the automobile, aerospace and other industries, now require the acquisition of training certificates (Robertson and Wareham, 1989). New workforce pronouncements often incorrectly assume that these new requirements reflect increased sophistication of the jobs themselves.

A key meaning of "sophisticated skill" has to do with appropriate attitudes on the job. The U.S. Department of Labor's recent report **Workplace Basics: Skills Employers Want** (Carnevale, et al., 1988, p. iii) tells us that "a new kind of American worker is being ordered up." And the most important qualifications of this new worker, according to the report, are "personal management skills": the ability to "maintain self-esteem, to set goals, to be motivated" (p.4). Workers must be capable of taking charge of their own working lives and their own career plans; they must be willing to change tasks at a job, to be retrained, and to change jobs any number of times during their working lives.

Workers must also want to have the "communication skills" necessary to fit into the company's "culture": to use its sophisticated information systems; to be a "team player," prepared to conform to the collective judgment of work teams to which one is assigned, and for whose performance one shares responsibility; to accept increased responsibility, without compensation, for "judgment calls" with customers.

The authors of one book on the new workforce (Lund and Hansen, 1985, p. 110) point out that sophisticated new workers are those who are willing to do any task, who are "willing to part with work rules that constrain the range of work an individual can do," who are, in other words, willing to give up hard-won job classification protections without hesitation. Workers with "mature, sophisticated" skills, they tell us, are those who "trust their employers."

They must also be willing to accept a new, more temporary arrangement with their employers, an arrangement in which a company's commitment to its workers is severely curtailed. According to the

Department of Labor report, the new worker "must be responsible for his or her own career development and job security" (Carnevale, 1988, p.4), a sort of freelancer who does not see himself or herself as dependent upon the employer for job security, advancement, or benefits. The new worker is someone, in other words, who has the "class" - the "sophistication" - to land on his or her feet, with no hard feelings, when the employer moves the plant to Korea or Singapore.

Such employee attitudes are critical to fast-paced, mobile corporate America, which is why it now refers to these attitudes as "skills."

* * * * *

Of course, the new "information society" requires not only compliant workers but also some workers with the skills to operate, monitor, and troubleshoot new systems in manufacturing and information industries. Just as the corporate world needs the attitudes, the trust and obedience - the hearts of the "new workers," so it needs their minds as well.

But the new sophisticated mental skills required of the new workplace are not nearly as sophisticated as they are portrayed to be. The call for such "abstract skills" as problem-solving and "higher-order thinking" is largely an attempt to harness and shape the minds of workers to the requirements of computerized systems. The corporate goal is to "retool" minds to fit the needs of retooled production systems in every industry (Licklider, 1982, p. 282), increasingly modeled after the continuous flow process methods of production characteristic of the petrochemical and utilities industries.

Such continuous flow information systems require handpicked, mindful operators, we are told, workers with the "communication skills" to give "clear, unambiguous instruction to the system," and to "receive and understand [information] from co-workers and fom computer interfaces." The "skills" of "alertness," visualization" and "attentiveness" are key new job characteristics. Shoshana Zuboff, 1988) of the Harvard Business School concurs, citing new "intellective skills" needed by workers "in the age of the smart machine," among them the patience and vigilance required to monitor continuous flows of information. No wonder, then, that it has been suggested that "the kind of people that will be willing to do that kind of job are probably being trained in our video arcades today" (Lund and Hansen, 1986, p. 94).

The Department of Labor report "Workplace Basics" states that "the employer's competitive edge is increasingly reliant upon how effectively and efficiently information workers and information machines are integrated and move through the production cycle together" (Carnevale, 1988, p. 1). Workers must be transformed into lowlevel astronauts (who still ride the bus to work), people who are prepared to give their undivided attention, their full minds, to the technologies surrounding them.

This giving one's mind to the technology is meant quite literally in another sense. "Knowledge engineers" are continuing management's efforts to simulate human intelligence and to package it in so-called "expert systems." Long-time, experienced workers are regularly "debriefed" by such engineers, tapping their knowledge, their strategies, their abilities to perceive visual information and to troubleshoot unique problems in complex systems, in preparation for a time "when the expert is gone" (Thompson, 1989). One GM advertisement exults,"Now one of your mechanic's tools is another man's mind."

"Sophistication" also refers to basic "analytical," "abstract" skills such as statistical control procedures, troubleshooting procedures, and the basics of computer protocols. But such skills are "abstract" in large part simply because they are used at a distance from the actual production process itself. An example is Zuboff's (1988) description of control room tasks removed fom the sights, smells and physical properties of the paper pulp mill itself.

Another example of "abstraction" is the "content-free, formal, closed conceptual system" imposed upon workers through the widespread use of integrated "manufacturing resource planning" (MRP) systems. Removed from the physical context of the production process, workers, now blind and anaesthetized, must rely exclusively on data and inferential procedures to monitor production. This would seem to be a clear instance of deskilling; yet this restrictive use of mind is, we are told (Berryman, 1988, p. 5), more sophisticated than "the traditional systems of knowledge that reflect accumulated managerial and production wisdom."

A final meaning of "sophisticated skill" is the ability to learn: flexibility, adaptability. "Learning is the new form of labor," Shoshana Zuboff (1988, p. 395) tells us. But what does this really mean?

The new workplace is not only a continuous process operation. It is, in theory, also infinitely flexible. Thanks to new, sophisticated technologies, flexible manufacturing systems will someday, management hopes, permit the production of a customized product without small batch production requiring major retooling. What will make all this possible, in theory, is that new "intelligent" computerized, robotic, production technologies will be adaptive and flexible, to the point of being able to retool themselves according to new product specifications. The plan is, in other words, that the machines will be able to learn.

Worker learning on the job amounts to the same thing. With the short life cycle of new products in a fast-paced, competitive economy, workers will also have to "retool themselves" constantly (now typically on their off-time, without pay (Robertson and Wareham, 1989). Just as they have begun to learn one system or product, they will be expected to start all over, learning another, and another, continuously. And not only does the short life cycle of accelerated product innovation force workers to learn continuously, "on-line"; decentralized production methods and leaner, streamlined workforces call for remaining workers to do many different jobs. Workers, in other words, will have to be multiskilled, according to the corporate line, flexible and adaptable, ready for any new job assignment.

How much technical expertise will such multiskilled workers need to have on all these jobs? Not much, according to one pair of experts (Lund and Hansen, 1986, p. 45), whose exhaustive survey of the needs of employers indicated that "the term **technical skill** was being used [by employers] to describe a familiarity and ability to feel 'comfortable' with technical processes, principally computers, [coupled with an ability] to interact with [CRT] displays to obtain required information and issue appropriate commands."

In this context, the "ability to learn" is a shallow substitute for real learning. It is adaptability, but not in the sense of intelligent wherewithall and cleverness; rather it is the kind of flexibility that blows which ever way the wind blows, with no inherent direction of its own. "Adaptability," wrote Harry Braverman (1974, p. 431), "- is this not a **definition** of unskilled labor?"

What is the new learning on the job like? As one "knowledge engineer" put it recently at a conference, it is "just in time learning" (Miller, 1989): continuous, on-line "fine-tuning" of the human component in the computerized, flexible production process, turning training into "the delivery of relevant, accessible instructional, guidance will be presented by miniaturized computer-based systems that offer needed information at the **precise** time it is required for effective action" (**Training**, 1988). Such "pinpointed skills," are the goal of the new learning and training in thinking and problem solving.

To conclude, the new corporate rhetoric about sophisticated skills is couched in attractive, seductive language: self-direction, motivation, a willingness to learn, problem-solving, autonomy, responsibility, flexibility, lifelong learning, mindfulness, attentiveness, "a nation of workers who think for a living" (Tucker, 1988) But the emphasis on new skills is really an instrument of bewilderment, dislocation and distraction. And the skills themselves are skills in subservience and compliance, in entrepreneurial abandonment of collective interests, in empty-headed mindfulness, and in incapacitating, alienated learning as the latest tool of production.

Harry Braverman (1974, p. 447), in his "Final Note on Skill" at the conclusion of **Labor and Monopoly Capital**, addressed an earlier, industrial version of the ideology about "skills upgrading." He concluded with the following observation:

> "The worker may remain a creature without knowledge or capacity, a mere "hand" [or mere "mind"] by which capital does its work, but so long as he or she **is adequate to the needs of capital** the worker is no longer to be considered ... unskilled." [49]

Indeed, in the latest "post-industrial" version of this phenomenon, the worker might even be considered "highly skilled," so long as he or she is an eager, adaptable cog, a flexible processing unit, in the high performance technological systems that meet the needs of capital at the present moment.

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READERS, AUTHORS, PROGRAMMERS, TEXTS: THE R-A-P-T MODEL OF CONSTRUCTING MEANING FROM INTERACTIVE FICTIONS

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This research was supported in part by an Ohio State University 1990 Academic Challenge Grant Research Stipend in Rhetoric and Composition.

I would like to talk today about my pilot study at the Ohio State University undertaken to investigate how computer interactive fictions complicate our current theories of reading and writing. One preliminary result of my inquiry is a proposal for a model of the production and consumption of computer texts, a model I am tentatively calling R-A-P-T (Reader-Author-Programmer-Text). In this preliminary study, I have attempted to describe the activities and special problems of participants (i.e., readers, authors, and programmers) at each corner of this proposed rhetorical square. In my examination of the new activities of the producers and consumers of texts prompted by computer-supported interactive fictions, I have relied on a methodology of interviews, discussions, and observations both at my home institution of Ohio State University and at the 1990 second annual Computer Game Developers' Conference in San Jose, California, as well as on my own stumbling experiences in co-writing computer interactive fictions.

Reading a disk of interactive fiction has been compared to having a conversation with the stupidest person one has ever met. Nonetheless, observing a reader's participation in the layered collaborations of creating and responding to computer-supported interactive fictions--disks of short stories or novels in which the reader "plays" a principal character--can increase our understanding of how meaning is created. After loaning four interactive stories *(Zork, Deadline, The Hitchhiker's Guide to the Galaxy, and Amnesia)* to eight novice readers of interactive fiction (all graduate students in a critical theory seminar in the Department of English), I convened an informal two-hour discussion of their reactions to these texts. Two related concerns surfaced in the discussion: the ethics of reading interactive fiction and the unexpected rigidity of the text. Not surprisingly, the novice readers based their descriptions of their narrative experiences on comparisons to their previous experience reading paper-based texts ("conventional" stories and novels). According to these new readers, in contrast to conventional novels, these interactive, or *participatory*, novels raise a new set of ethical problems for their participants. For example, in order to progress through these interactive stories, readers must often commit acts of violence (such as killing trolls) or behave in ways out of character for them. If the reader refuses to type in a response such as "kill the troll," the story will stop right there, the narrative progression will cease. (Further, often the reader is killed if he or she does not type in the "correct" violent response.) Thus, these novice readers reported a new--and unsatisfying--sense of culpability in their reading experiences. In reality, they claimed, the interactive fiction texts they were reading forced a choice between ethical behavior and narrative progression. In contrast to the readers' identification with occasionally crooked characters in *conventional* paper texts, their identification with violent characters in *interactive* texts felt more rigidly constrained. In short, then, these computer-supported interactive texts felt more constrained to these novice readers, and they reported that their reading experiences were surprisingly stressful.

On the other hand, the expert readers I talked with had very different experiences of computer-based interactive fiction texts. My informal observations and interviews of two computer programmers reading commercial interactive texts revealed definite differences between how they and the novice readers apprehended these texts. For an expert reader of interactive fiction, the reading is accompanied by a system of peripheral activities: mapping; score-keeping; posting questions and answers on computer gaming bulletin boards; discussions in *users' groups;* looking "under" the game at the programming code. Further, the essential comparison for an expert reader is between the current game and past games read--a comparison different from a novice reader's contrast between a computer text and previously read paper texts. An important component of an expert reading of interactive fiction is this comparison with other examples of the genre. For example, expert readers of interactive fiction ask how a current puzzle (such as finding a charm to open a door) is different from puzzles in other games. Further, according to these preliminary observations of these two programmers reading, expert readers have a very different view of the *purpose* of their reading. They explored these texts as a series of puzzles to be solved, instead of as the possibility of a rich narrative experience. Of course, some of the differences in activity between the novice and expert readers can easily be ascribed to differences in training and interest between English graduate students and computer scientists.

Expert and novice readers of interactive fictions seem clearly divided; however, both novice and expert authors face the same challenges and constraints in writing one of these texts. Authoring a computer-based interactive fiction is very different from writing conventional fiction. Based on my own experiences working with a programmer to create a computer interactive text, I think the author is engaged in a new activity of atomizing incident, digitizing character, and selecting (and inventing) the series of rules that will best create and predict behavior of character, incident, and setting. For example, even modelling a cat's behavior in an interactive text entails writing a series of if-then rules that will account for any eventuality; the writer, to some extent, must account for unseen events, such as a reader typing in a response that he has brought a pizza pie into the cat's room and dropped it. The writer must create the cat so the cat is always ready to act. The author, to a reasonable extent, engages in an activity of predicting reader responses. Further, there are new dimensions of graphics, sound, font, scale, and color in the production of an electronic text. The interactive fiction writer must successfully manipulate these dimensions of presentation of narrative, as well.

The programmer holds a different set of concerns than the writer in composing interactive fictions. The central concern for a programmer is the design of a reactive architecture that will successfully and satisfyingly respond to readers. The programmer sees the text as a system that responds to a user in interesting, rich, useful, and usually logical ways. One programmer I talked with at the *Computer Game Developers' Conference* told me that he sees all interactive fictions as the first primitive step towards responsive virtual realities and reader (user) interactions with three-dimensional invented characters in cyberspace. The reactive architectures designed by programmers for text-based adventures ideally may be imported to more persuasive and extravagant illusionary environments. The programmer's work in creating interactive fictions is a preliminary step towards more powerful, multidimensional reactive architectures.

Finally, in computer-based interactive fictions, the text becomes a fictive arena for interactions between the programming/writing team and the reader. Among other things, the text becomes a repository for the traces of readers and writers interacting. Thus, ultimately, the text becomes a new fictive entity that demands a new literary theory and criticism to understand its effects and how it works. Richard Lanham, Gregory Ulmer, Michael Heims, and others are beginning to explore the new dimensions of electronic language-making activities, but much more work needs to be done.

Obviously, my brief presentation here today is merely speculative, and much more rigorous investigation of interactive fiction and electronic texts needs to be

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undertaken, especially by those in the field of writing. I am here merely to share with you my first thoughts about how interactive fiction is changing the activities of reading and writing, and my first ideas towards creating a model, R-A-P-T, that will reflect these new activities.

THE IMAGE OF THE ENGINEER IN THE POPULAR IMAGINATION, 1880-1980

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It is the thesis of this discussion that the image of the engineer in the popular imagination is a direct reflection of the American attitude towards technology and technological development in general. As American attitudes toward technology grew more favorable, the image of the engineer was placed in a favorable light, and as the American attitudes towards technology grew less enthusiastic, the image of the engineer became confused and problematic. The image of the engineer in the popular imagination can be seen in a variety of media; here it will be discussed primarily as it appears in popular fiction.

If one were to record the popularity of the engineer as represented in the popular American imagination during the last 150 years, the curve representing the engineer's popularity would first appear around 1850, show a rapid rise to its greatest height just before World War I, decline slowly until after the end of World War II, and then fall drastically in the 1960s, when American involvement in Vietnam began to be seriously questioned. And as popular approval of the profession of engineering waxed and waned, youthful interest in engineering demonstrated similar patterns.

Technological development in society is reflected most clearly in improvements in transportation, in obtaining and processing raw materials, and in the development of implements of national defense. These are the activities with which engineers are most directly associated, and their appearance in popular media is linked to one of these activities. As the end of the 19th century arrived, engineers were a new kind of professional. In keeping with the belief, stated most prominently by English scientist Thomas Henry Huxley, that science would eliminate ignorance and supplant religion as a foundation of human progress and belief (Krutch 39-42), engineers began to appear as the operators responsible for translating the theories and concepts of scientists into the practical applications necessary for an improved society. As early as 1852 American civil engineers had identified themselves as members of a specialized branch of the engineering profession, for that was the year in which their society was formed. Other groups began forming and by 1950 there were over twenty different kinds of engineering societies (Florman, 6).

One of the first writers to place engineers at the center of their works was the Frenchman Jules Verne, who created stories in the 1860s and 1870s describing balloons, submarines, airships, and projectiles to the moon. For Verne, technologically-designed and developed structures like submarines and airships could be created only by determined individuals who understood scientific principles and who knew how to translate their understanding into products and activities. He called these individuals engineers, and cast them as the central figures of his two most famous works, 20,000 Leagues Under the Sea (1869) and Mysterious Island (1874).

In 20,000 Leagues Under the Sea the key figure is Captain Nemo, an outcast of society who turns his engineering expertise into a means of revenge against a society that is persecuting him. Nemo's submarine, the Nautilus, is a masterpiece of marine engineering that can overcome all but the most formidable of undersea challenges. The Nautilus combines the latest developments in several engineering areas, including mechanical, hydraulic, and electrical engineering. The Nautilus represents one of the earliest forms of a technological utopia (at least for Nemo and his crew).

Perhaps because Verne was sensitive to criticism of 20,000 Leagues that saw it as glorifying the destructive actions of Nemo and his crew, he portrays the effects of engineering knowledge in a different light in the sequel, Mysterious Island. In this novel, Verne presents the Union officer Cyrus Harding as a model of technological idealism. An engineer familiar with scientific principles and manufacturing processes, Harding confidently inspires his band of five castaways on a mysterious island in the south Pacific. Harding's engineering background provides the key to their success; Harding is described by one of the men as "a microcosm, a compound of every science, a possessor of all human knowledge" (55). With Harding's help the settlers construct a telegraph system, two dams, a ship, and a hydraulic elevator, among other engineering achievements. At the end of their stay they meet Captain Nemo, who has been providing essential assistance in their struggle to survive. Their visit to him as he lies on his death-bed on the Nautilus is presented as a kind of religious pilgrimage to a god-like figure whose power is the power of applied technology. While his appearance in the novel is brief, his significance is immense; Nemo and his submarine represent the tremendous potential of technology.

The imaginative impetus that Verne gave to the profession of engineering continued into the twentieth century. We can easily appreciate the sentiments of the president of the American Society of Civil Engineers who, at a meeting of the group in 1902, told the assembled engineers that "in the future, even more than in the present, will the secrets of power be in [the engineer's] keeping, and more and more will he be a benefactor of men." As Samuel Florman says, "to be an engineer in 1902 . . . was to be a participant in a great adventure, a leader in a great crusade" (Florman, 4).

One indication of the popular belief in the potential of engineering was the rapid rise of the engineer as a central character in popular fiction. As engineering know-how created observable effects on the world around, popular novels described these individuals in romantic and adventurous guises. Cecelia Tichi has observed that "from the turn of the century through the 1910s a new American hero--the engineer--entered popular American fiction." This new American hero, she says, displayed "actions and qualities of mind reveal[ing] the hopes and anxieties of the cultural movement" (Tichi, 117). Some of these early works were widely read and many of their titles remain familiar today: John Fox's The Trail of the Lonesome Pine (1908); Harold Bell Wright's The Winning of Barbara Worth (1911); and Zane Grey's The U[nion] P[acific] Trail (1918). Although the idea of the American hero as a tough, resourceful individual was not new, the idea of the engineer as hero was new and unusual.

The engineer was featured also in children's books, especially from 1910 on. The most important manifestation was Tom Swift, whose 38-book series was published from 1910 through 1938, amounting to a total sale of over 20 million books (Dizer, 12). Although Tom Swift is not described specifically as an engineer, he and his inventor father share an interest in mechanical operations. Tom is described as having a "natural love for machinery, and it hurt him almost as much to see a piece of fine apparatus abused as it did to see an animal mistreated" (Tom Swift and his Motorcycle, 28). Nearly every one of Tom Swift's adventures focus on some recent real technological development. Tom Swift himself seems to have been modeled at least in part on a mechanically-minded inventor who lived in central New York state: Glenn Curtiss, the aviation pioneer who rivaled the Wright brothers' aeronautical achievements (Dizer, 36-42).

The engineering and technological impetus was clearly felt in juvenile series books published from 1905 through the early 1920s; an informal survey in a recent bibliography of juvenile series boys' books having a direct link to engineering or technological activity shows that there were over twenty series published amounting to a total book count of nearly 150, not including the Tom Swift books. With a cultural impact of this sort, it is not surprising that the engineering field grew phenomenally in the years between the wars, as the 19th century educational system of emphasis on the word was replaced with the 20th century educational system with the emphasis on the thing.

In adult popular literature prior to World War II the image of the engineer was changing from romantic hero to ambiguous operator of modern forces of civilization. The dramas of Eugene O'Neill often featured individuals simultaneously empowered and entrapped by the forces of technology (Yank in The Hairy Ape, 1921; Reuben Light in Dynamo, 1929). A similar view is expressed in Karel Capek's 1923 play R.U.R., the work that introduced the word robot to the English language, as well as in two distopian works, Eugene Zamiatin's We (1924), and Aldous Huxley's Brave New World (1932). Although some essayists were skeptical, popular American literature continued to portray the forces of engineering and technological development in a more positive than negative light.

The events of World War II simultaneously marked technology's greatest achievement--the defeat of the century's worst political and military threat--and the beginning of its decline--in the invention of the weaponry that helped to achieve that defeat. After World War II the decline in the perceived value of technology became increasingly apparent, and social commentators began to suggest, not for the first time, but in greater numbers and with greater evidence, that technological development in itself was not a panacea, and could not prevent either social or political unhappiness. Samuel Florman sets the date of the "beginning of the downfall of the engineer" at January 31, 1950, the date on which President Truman announced that work would begin on the development of the hydrogen bomb (Florman, 12).

In 1960 the engineering profession fell into increasing disfavor after it was attacked in Vance Packard's The Waste Makers. Packard argued that engineers had been participating in the planned obsolescence of consumer products (Florman, 13). Some postwar writers like Eugene Burdick (The 480) and William J. Lederer (The Ugly American; Burdick was co-author) attempted to recover the tradition of the engineer as hero, but the popular mood was not receptive. Engineers began to be increasingly shown as obsessed and self-serving corporate climbers (Kurt Vonnegut's Player Piano), obsessed over-achievers (Ayn Rand's The Fountainhead and Atlas Shrugged), or naive innocents unaware of the impact of their work on society (Nevil Shute's No Highway). Reaction to American involvement in the war in Vietnam reinforced suspicion of engineering purposes and capabilities. The futility of the war effort and of engineering's association with it was illustrated in the use of high-technology weapons to destroy foliage and the unworkable suggestion of Secretary of Defense Robert MacNamara to build an electronic fence between north and south Vietnam.

As the American reaction to involvement in Vietnam began to subside, a different kind of engineering hero appeared, shown primarily in the fantastic action drama, The A-Team, in which engineering knowhow is used to create weapons and instruments of destruction. Interestingly, the cast of characters in the A-Team series are described as having received their training in combat in Vietnam. This application of engineering skills hardly placed the engineering profession in a favorable light; however, subsequent representations were even less fortunate: in the television series Riptide, the engineer is a character whose function is as much comic relief as it is to demonstrate engineering and mathematical genius. Most recently the comic image of the engineer has been exaggerated further, as the engineer has become the leading figure in a group of misfits known collectively as nerds. In two recent movies (The Revenge of the Nerds; The Revenge of the Nerds, Part II), engineering students are depicted as intellectual overachievers but as social outcasts, whose single-minded devotion to knowledge marks them as types separate from typical American students. Their main achievement in both films is to use their technological knowhow (reduced to producing electronic musical entertainment or an A-Team type of retributive activity) to force their acceptance on a suspicious and pleasure-oriented society.

The image of nerds struggling for acceptance into a society oriented towards affluence and the good life is not likely to create a desirable role model for today's youth. Whereas in 1920 the mechanically-minded youth could follow Tom Swift into undreamed-of worlds of adventure and romance, today's youths are forced to watch would-be engineers run around in their underwear suffering repeated indignities and abuse. The obvious effects of these images upon young men and women making career choices have been recognized by experts in the engineering recruitment area. A recent article in the _Dayton_ _Daily_ _News_ indicated that "the declining numbers of women in engineering programs reflect a general decline of both men and women studying engineering." "Since 1983," the article stated, "engineering enrollments throughout the country have declined by one-third." One authority, Dr. H. Judith Jarrell, suggested that women don't choose to study engineering because they don't know much about it; as she put it, "There's no _L_. _A_. _Law_ [a popular television program about lawyers] for engineering" ("Engineering," 6B, 9B).

Brian Rowe, senior vice president, aircraft engines division, General Electric Company, speaking at a conference in August of 1989, expressed serious concern over the decreasing size of the potential enginering work force. According to Rowe, only one out of seventeen high school students currently enters an engineering or scientific program in college; in Japan, the ratio is one in six. Rowe was not encouraged to hear that "seventy thousand engineers graduated" from college recently, because the National Science Foundation learned that in 1986 "forty percent of all aeronautical engineers were over the age of 50" (Rowe, 50). Those engineers who might have been influenced to choose a career in engineering by reading the adventures of Tom Swift and his friends are about to retire; the ranks of those replacing them--those motivated by images of nerds or Dr. Strangeloves--are thin.

The engineer first appeared as a hero. Now the engineer has become a clown. Perhaps we need to recognize that the engineer is neither, but is typically a skilled individual committed to helping society do its work better and more efficiently. The engineering profession is currently confronted with a comic cultural caricaturization which must be revised and enhanced if it is to appeal to American youths as an avenue for useful and productive employment whose output will continue to benefit both the individual and society.

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CONSCIOUS TECHNOLOGY: A CANDIDATE WORLD VIEW

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There may be a subconscious consensus about the future. That consensus is that human beings will be as integrated with technology as technology will be integrated with consciousness. When distinctions between human and machine blur, we will have reached what could properly be called the Conscious Technology civilization.

The leading indicators of this civilization are already with us. The whole thrust of cyborg advances is to take the best of our external technology, miniaturize it, and then make it part of our bodies. There's the Jarvik heart, Utah Arm, artificial kidneys, Boston elbow, miniature pancreas-like pumps, Triad hip, heart pacemakers, microelectronically driven limbs, intraocular eye lenses, MIT knee, plastic skin, artificial ears, blood vessels, and bones. This represents a very strong trend toward the "cyborginization' of humanity.

Simultaneously, the whole thrust of electronics is to make inanimate objects immediately responsive to our thoughts. We can talk to computers that recognize over 5,000 words. Buildings have sensors that make them seem alive like HAL in the movie *2001: A Space Odyssey*. Computers are becoming mobile and self-programming robots.

The US Census Bureau has been counting robots as well as people since 1984. There were 5,535 complete robots in 1984 valued at $306.7 million. By 1995 we expect 250,000 robots in American industry, but the total could be well over a million including personal robots. With advancing computer power, micro-miniaturization, and voice recognition, we can tell many inanimate objects what to do ***and*** they can tell us what to do. Our whole environment will seem to change from dumb matter to conscious partners as we tell our telephones to phone home, our lights to turn off, and our music to turn on.

If we project the trends of humans becoming more technology-like and project the trends of technology becoming more human-like, we eventually hit a point when the two directions cross over into one trend, the trend of Conscious Technology.

Concurrent with these developments is an explosion in human consciousness. Consciousness creates technology, which in turn, expands our consciousness, which in turn improves our technology, and so forth. Yet, there is a critical impediment that is intimately bound up in this notion of Conscious Technology, that impediment is prejudice. Prejudice is a primary inhibiting factor of many positive alternative futures. One example is the prejudice between mystics and technocrats. Tool makers and consciousness shares have looked down on each other throughout the ages and across the earth. Is it possible to merge the mystic's attitude toward the world and the technocrat's knowledge of the world? I think yes.

Imagine everything around you with the most divine meaning. This is the mystic's view. Now imagine everything around you with the most mechanical of relationships. This is the technocrat's view. If you can imagine both views simultaneously, then you experience the Conscious Technology view of the things around you.

You can try it out the next time you go shopping. See geometric relations of the center of gravity in a bag of groceries you are carrying out of the store. Note the meanings of not having your hands carrying it relative to the center of gravity. Some say the experience of "balance" is divine. So you could imagine the mechanical relations and the divine experience together. Conscious technology views them as one.

It is well documented that the last 200 years have seen a dramatic increase in social mobility and communications, putting more diverse world views in direct exchange. This makes some unsure what to believe and they turn to the past for comfort; hence, the resurgence and popularization of fundamentalism in many forms. Simultaneously, development continues in robots, cyborgs, computer communications, space flight, brain research, biological engineering, micro-miniaturization, and international commerce.

Conscious Technology is a candidate world view to resolve the social polarity existent in many cultures. I define a mystic as one whose first reaction to a problem or opportunity is to share consciousness and a technocrat as one whose first reaction to a problem or opportunity is to make or share a tool. We are all part mystic and part technocrat, but we tend toward one world view or the other. Conscious Technology is the merger of the two.

One policy implication of this view is that you should learn more about your opposite orientation. The more mystically inclined would study science and technology, while the more technocratically inclined would study consciousness. A second implication is a challenge to level theory. Level theory holds that life stacks up like a layer cake: mental is higher than physical; spiritual is a higher level than mental; love and belongingness are a higher level than physics; nation is a higher level than city; the computer is a higher level than pencil and paper; and reading is a higher level than cooking.

Most will agree that when they say something is on one level as opposed to another level, they simply mean it is different. Adding the word "level," they may feel, dignifies the statement, when it actually detracts from its meaning. Some say "on the mathematical level," as opposed to the "psychological level." It would be more accurate to say "mathematically" as distinct from "psychologically."

An alternative to level theory is spherical theory. Spherical viewing is easier for astronauts and cosmonauts to understand than for Earthkind. On earth, we see level streets, layered buildings, horizons of oceans, and flat lakes. In earth orbit, "up" and "down" (concepts implicit to level theory) are meaningless. "In" and "out" make more sense. Let me give a few more illustrations. A fertilized egg grows in a sphere, then differentiates, yet grows outward from its center. The sun radiates in an infinite number of directions. Ripples expand radially from the surface where a rock hits the water. Your voice emanates in all directions.

Life acts spherically, yet we seem to learn and understand in levels. We use a map to understand the territory, but must remember not to confuse the map with the territory. Our body heat radiates in all directions, but we use a linear thermometer to understand our temperature.

Like the sun, our brain radiates a measurable spherical field. We can measure these radiations and talk about their level of intensity. But we should not confuse the thing being measured with our measurement of the radiation of the thing. The brain acts spherically; we measure linearly. We confuse the two when we speak about our consciousness as if it were a layer cake.

This confusion has become a source of prejudice, as one person is seen as having a higher level of consciousness than another, instead of being a different person than another.

It is difficult to see yourself and others as superior or inferior without some particular linear measure. Instead, imagine yourself as a sphere. Now from your center point, imagine an infinite number of rays extending in all directions. Each ray has a different aspect such as mathematics, art, financial security, love, politics, etc. Each ray would extend as far as you have developed that aspect. Each person has a different shape, they wouldn't be higher or lower consciousness. In the same way, the mystic would not be higher or lower than the technocrat and consciousness would not be higher or lower than technology. The goal of spherical theory is to be well rounded, while the goal in level theory is to climb up, and that climb is often over someone else's back.

Conscious Technology can be a criterion for policy analysis, i.e., does the policy increase or decrease the synthesis of consciousness and technology *or* does it redress an imbalance between the two? It can also be a guide to the future for product development. For example, how can technology be designed to more enlighten our consciousness? Finally, it can be utilized in technological forecasting by making the assumption that each new technology also adds increased interconnection to our consciousness.

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TECHNOLOGY AND DEVELOPMENT:
A Study of the Washington Public Power Supply System

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Introduction

Many in the policy and research communities project the imminent demise of nuclear power (Flavin, 1989; Campbell, 1988). Inefficient, costly, and unable to resolve the problems of plant decommissioning and waste disposal, nuclear power is portrayed as a technological failure. Yet, a close examination of the current energy and environmental policy debates suggests that eulogies for the industry may be premature. With international concern over global warming trends, there has been renewed advocacy for this technology as a "clean solution" to the greenhouse and other environmental problems associated with a carbon-based economy (New Scientist, 1988; Weinberg, 1989). Further, countries such as the Republic of Korea, which lack domestic energy sources regard the utilization of this technology as essential to industrial development (Choson Daily News, 1989). Finally, a new generation of what is termed "inherently safe" reactor technology is being heralded as providing a solution to the perennial problems of health and safety which have plagued nuclear power (New York Times, 1989; see also Weinberg, 1989-90).

What is striking about the debate over the second nuclear era is its unbroken continuity with that of the first era. In both, the focus has been on the "future tense" of what is promised by and what can be believed about nuclear power. In our view, this orientation misdirects the efforts of social evaluation and criticism by concentrating analysis on the relative costs and benefits of the technology's projected performance. Left out of such analysis is a "present tense" understanding (Noble, 1983) of the politics, economics and technics of nuclear power. This omission results in the actual social interests and values of nuclear power being made abstract, while its possibilities are treated as though they were concrete. Society as a whole, but especially those who are most immediately threatened by the advance of the technology--plant neighbors and workers--are placed in the untenable position of having to argue against progress. The study of specific case histories, such as the attempt by the Washington Public Power Supply System (WPPSS) to simultaneously build five nuclear power plants, offers one important method for developing a present tense understanding of the technology.

Our analysis is presented in four parts. In the first section, we provide a brief overview of the rise and apparent fall of WPPSS. We then locate the movement toward regionalization within an institutional and ideological context which equated social progress with increased energy production and consumption and with technical advance. Third, we document the resulting transference of autonomy over the specification of ends and the criteria for public policy decisions from the political to the technocratic sphere. The article closes with our assessment of future tendencies in regional energy policy.

Toward the Single Utility

On January 22, 1982, construction was terminated on two of five WPPSS nuclear power projects, setting in motion the largest municipal bond default in the history of the United States: $2.1 billion in bonds issued to finance two of five plants being built (Falk, 1985). Additional debt of $6.7 billion in principal and an estimated $23.8 billion in interest, which was accumulated to underwrite the five-plant project is also in jeopardy (Morrison, 1981; Loeb, 1982).

The WPPSS default can be located within the context of the centralizing tendencies historically present in the region. As early as 1937, when the federal government established the Bonneville Power Administration (BPA), steps were taken to organize the production, distribution and marketing of electricity on a regional basis. The trend toward regionwide cooperation accelerated during World War II as U.S. military planners sought to take advantage of the surplus of low cost electricity in the area for the manufacture of military aircraft. The federal government also built aluminum plants in the region to supply military needs, further adding to the demand for electricity (Balmer, 1983: 646). By 1942, 92 percent of BPA's load was committed to industrial producers of military hardware (Blumm, 1983: 203).

After the war these plants were privatized and the region's aluminum and aircraft manufacturers returned to civilian production. BPA responded to the burgeoning needs of its industrial customers by adopting a sales policy which offered large blocks of power at discount rates (Blumm, 1983: 206). It also initiated efforts to bring electricity users and providers together to plan for the post-war energy needs of the region. The Pacific Northwest Utilities Conference Committee (PNUCC) was organized by BPA in 1948 (the Northwest Power Pool having been created in 1942) and was charged with "the development of analytical tools to determine, on a rational basis, the relative costs and benefits of the various resources available to meet the Northwest's energy loads" (PNUCC, 1985). Together, the activities of the War Department, BPA and the PNUCC put the Pacific Northwest on a clear course toward regionalizing power supplies.

By the early 1950s many IOUs in the region which had previously depended heavily upon BPA for power supplies undertook joint projects to build and operate large-scale plants (Balmer, 1983: 649). These joint projects, together with efforts by the Eisenhower administration to weaken the preference clause in the BPA charter (which favored public power), were interpreted by public power providers as threats to their market share (Blumm, 1983: 210). In 1956, 17 Washington State public utilities and municipal authorities banded together as WPPSS in order to protect their collective interests. The technical and economic advantages of regional cooperation were demonstrated in 1964 with the completion of the Packwood Lake hydroelectric facility, a 27.5 MW plant. While the project ran 25 percent over budget and was seven months behind schedule (Leigland and Lamb, 1986: 4-5), it was viewed as a success because public power had established its capacity as an independent source of regional generation projects. Encouraged by this success, WPPSS sought to establish the ability of public power to operate at a scale and with technologies as sophisticated as those employed by IOUs. Planning was begun in 1962 to purchase and convert to electricity the excess heat from an 860 MW military reactor to be built at the Hanford Nuclear Reservation in northeastern Washington State (commonly known as the N-reactor). While the project, which went into commercial operation in November 1966, was significant for several reasons perhaps its most important contribution was that it demonstrated the viability of civilian nuclear power as a seemingly cheap and reliable source of electricity for the region.

The final step necessary for the completion of the regional electric network was the establishment of cooperative ventures among BPA, WPPSS and the IOUs. The Hydro-Thermal Power Program (HTPP) served this end. Initially discussed in a 1958 Corps of Engineers report, the proposal was not acted upon until 1968 when a way was found to establish joint participation and control by public and private producers over the Program. The HTPP incorporated the Army Corps plan to add 20,000 MW of hydropower by completing the Columbia River system, while simultaneously calling for public and private utilities to build a combination of 22 coal and nuclear thermal power plants with an output of 21,400 MW over the following twenty years.

In the following year, the Council program was refined into a Phase 1 plan to build seven plants by 1980 with a capacity of 7,930 MW. Carrying out even this scaled-down version, however, still required a substantial commitment to new plant construction. BPA proposed that WPPSS act as construction manager for three nuclear plants with a total rated output of 3,580 MW; the other 4,630 MW would come from IOU projects already planned or underway. Almost immediately, however, Phase I of the HTPP was diagnosed as insufficient. In 1970 the PNUCC forecasted electricity demand at almost 18,000 MW by 1979-80 (Gleckman, 1984: 10), which if true, would absorb all of the new capacity proposed under Phase I. By 1972 BPA was forecasting power shortages for the decade under low water conditions (Blumm, 1983: 225). The final blow to Phase I was a 1972 Internal Revenue Service ruling declaring "net billing" in violation of BPA's charter proscription against the direct purchase of electricity. Net billing, a critical factor in Phase I planning, was an arrangement among the utilities, BPA and WPPSS whereby participating utilities would purchase nuclear power at a price equal to the net difference between the cost of a utility's normal hydropower purchase from BPA and the cost of its share of output from the new plants.

In spite of these difficulties, by late 1973 BPA and the utilities agreed upon Phase 2 of the HTPP. Eleven plants with 11,300 MW of capacity would be added by 1987, of which 5,800 MW would come from nuclear facilities. These plants were in addition to the three Phase 1 projects. WPPSS agreed to build two nuclear plants with a rated output of 2,500 MW, while IOUs would construct six coal-fired and three nuclear units. Thus, by 1976 WPPSS was simultaneously building five nuclear plants with a combined rated output of 6,080 MW at a projected cost of $4.265 billion. The last plant was to come on-line in September 1987 (Heutte, 1982: 3).

Through the HTPP, a political milestone of regionwide cooperation in planning, forecasting, plant construction and power distribution and transmission was achieved. The Program joined rivals such as public and private power, BPA and the region's major electricity-using industries in a synergistic relationship. Interests which for 50 years had been perceived as conflicting, were now seen as complementary. Cooperation between BPA, WPPSS and the IOU's was essential: BPA to develop and sustain regional markets; and WPPSS and the IOUs, to build the plants which would complete the electrical network. In the HTPP disparate interests were combined to function as a single utility.

The Institutionalization of Megapower

The single utility framework that emerged in the Northwest in the 1960s and 1970s was dictated by the developmental requirements of a technological system. Distinguishing between the technical and the technological is necessary for understanding the evolution of the region's electrical system: "Technical refers primarily to tools, machines, structures and other devices...[F]actors embedded in technology besides the technical are the economic, political, scientific, sociological, psychological and ideological" (Hughes, 1980: 142). The problem for the Northwest was not whether and how to build large-scale power facilities. There already existed in the region knowledge, capital and organizations that could be combined to build and operate power plants. Moreover, BPA and the utilities had fashioned rate policies and distribution networks that could effectively market the power generated by their machines. If the HTPP is seen simply as a statement of technical need, it could have been implemented as a series of individual projects.

The HTPP was not a plan to build 22 or 7 or 11 power plants. Instead, the Program was part of a developmental sequence which was guided by the assumption that regional growth required the expansion of the electrical network. The HTPP represented a logical response to the region's energy needs within a technological system predicated upon the axiom that "civilization = k(energy);" or as Aldous Huxley once remarked, "because we use a hundred and ten times as much coal as our ancestors, we believe ourselves a hundred and ten times better, intellectually, morally, and spiritually" (for both see Basalla, 1980: 40). The attraction of megapower is deeply rooted in American myth and values. Throughout its industrial history, the society has equated national wealth with energy use, so much so that the two are often seen as synonymous (Ward, 1977). Electric power plants have occupied a special status in this ideological attitude, representing the technical archetype for the realization of cheap and abundant energy; the ideal "abundant energy machine" (Byrne and Rich, 1986). For seven decades, experience with electrical technology seemed to confirm the ideal. Average thermal efficiency of plants increased nearly eightfold from 1900 to 1970 while the size of facilities grew by a factor of eleven (Ross and Williams, 1977: 12-14). These technical achievements were matched by steady declines in the average price per kW from 1899 to 1969 (Bergman, 1982: 65).

The Northwest had for a long time experienced the advantages of megapower. Home to the largest hydroelectric system in the world, several of the world's largest dams, and the cheapest electricity in the United States, the region has routinely supported large-scale, centralized electrical generation. A BPA administrator reflected this regional consensus in a 1966 speech: "I am sure that I don't need to convince this group [of area utility executives] of the economies of scale. I don't think anyone here would urge the route of small, less efficient plants" (in Gleckman, 1984: 5). The region's adoption of nuclear power was a natural extension of the megapower ethos.

But nuclear power's institutional importance goes still deeper. A U.S. Department of Energy official spelled out the general rationale for the promotion of nuclear power in Western societies: "nuclear is the only nonfossil energy source that will be available to us in sufficient amounts to support our civilization and to fuel progress for the foreseeable future" (Agnew, 1983: 1). By this standard, even cost, the crucial capitalist measure of worth, cannot alone halt the pursuit of nuclear power since enthusiasm for the technology is not primarily rooted in its purportedly superior engineering or economic properties. Rather, nuclear power's appeal is explained by its compatibility with a particular technological system. Within the megapower paradigm, nuclear power, and possibly only nuclear power, can be understood as capable of meeting the region's "civilization needs." Seen in this light, the operant question is not whether or why but how the nuclear energy machine can be made to work. A technological society accepts the necessity of nuclear power and its inherent risks. In fact, it may seek to dismiss the risks, as when The Economist, one month before the Chernobyl accident, judged a nuclear plant to be "as safe as a chocolate factory" (1986: 11). A Soviet official similarly tried to minimize the risk after the Chernobyl accident: "[T]here is bound to be a technical incident...We can say that this is a normal incident, and there is nothing abnormal" (Associated Press, May 12, 1986). The New York Times in an August 25, 1986 editorial agreed: "Chernobyl is a lesson to improve safety, not throw in the towel...More accidents are certain."

Langdon Winner has observed that "technological society tends to arrange all situations of choice, judgement and decisions in such a way that only instrumental concerns have any true impact. In these situations, questions of 'how' tend to overpower and retailor questions of 'why' so that the two matters become, for all practical purposes, indistinguishable" (1977: 232-233). Northwest power development has adhered to this technocratic principle. Historic divisions of political and economic interest such as those underlying public versus private power and sagebrush resentment of federal control have regularly been superseded by the requirements of megapower. Despite deep suspicions and mistrust among electric generators, marketers and distributors, the region has witnessed an extraordinary proliferation of cooperative technocratic ventures. The Northwest Power Pool, the Pacific Northwest Coordination Agreement, the Western Systems Coordinating Council, the Mid-Columbia Hourly Coordination Agreements, as well as the alphabet organizations already discussed (the PNUCC, JPPC, WPPSS, and the HTPP), were all created to elevate regional discussion and action above the merely political so that the higher concerns of technological coordination could be met. The energy problem was framed by these ventures around issues of adequate and reliable supplies, transmission and distribution, and the capacity of the region to finance and manage a growing and more complex electrical network. These are questions of science, engineering and business management best handled by those with technical training. As Balmer suggests, the region has come to rely heavily upon its technical experts in policy matters. "We have seen the shift over time from a decidedly hostile coexistence of public and private power to a growing technological interdependence which...[has] led to an era of policymaking by relatively autonomous technocrats" (Balmer, 1983: 659).

Northwest power planning under the HTPP emphasized "technical virtuosity as a style" (Lee, 1980: 90). Managers at BPA and WPPSS tended to have engineering or other scientific backgrounds, adopted "scientific approaches" toward management matters, emphasized formal control in the organization of work and, above all, did not "play politics" (Leigland and Lamb, 1986: 75). To plan and manage the construction of five nuclear projects, several of the largest and most prestigious technology and investment firms were relied upon for technical counsel and management services (Leigland and Lamb, 1986: 60-67). Merrill Lynch, Paine Webber, Salomon Brothers and Blythe Eastman Dillon worked for WPPSS, as did Bechtel and the "big four" reactor vendors--General Electric, Westinghouse, Babcock and Wilcox and Combustion Engineering. Undergirding WPPSS was a transnational complex of corporations, interlocked with the largest U.S. banks, insurance companies and law firms (Leigland and Lamb, 1986: 183). The energy problem, as these organizations defined it, required specialized knowledge, planning and coordination to be solved.

This technocratic orientation largely precluded assessment of alternatives to large-scale centralized production. "By training and by tradition, all the utilities were growth oriented, concerned with meeting needs before they arose, and unreceptive to the idea that conservation...might be substituted for increased supplies of power" (Balmer, 1983: 651). The technocratic bias neglected two possibilities. First, it was assumed that the WPPSS projects would continue the pattern of low power prices for the region. In fact, the Pacific Northwest has discovered that megapower can be a major cause of spiraling prices. Second, the treatment of conservation as curtailment rather than as a supply option meant that the greatest advantages of the conservation strategy were ignored. In particular, the possibility that conservation investments might result in lower costs per kW saved than investments to supply a kW was overlooked.

Indeed, despite decade-long experience with significant construction delays, rising costs, and increasing electric rates (averaging over 86 percent in December 1979--see Sugai, 1987: 351), it was not until the approval of Initiative 394 in November 1981 that WPPSS bond sales were subjected to ratepayer referendum. Citizen protests were few and unorganized before late 1980--"any direct attack upon the Supply System would fail to elicit majority public support" (Sugai, 1987: 8)--and reached their peak in January 1982 with the termination of WNP 4 and 5. By that time, ratepayers had mobilized into a series of organizations, including "Irate Ratepayers" chapters, the "Don't Bankrupt Washington" coalition, and the "Progress Under Democracy" committee. But with the cancellation of two projects and mothballing of two others, activism quickly waned and in September 1982 efforts to form an umbrella coalition were dropped (Sugai, 1987: 363). This is not meant to diminish citizen activism in the Northwest. Rather, the short life of mass protest in the region and its limited accomplishments underscore the considerable problem faced by citizen groups in affecting, much less controlling, the activities and direction of a technocratic regime such as that ruling Northwest energy policy.

WPPSS, BPA and the HTPP together constitute a technostructure predicated upon the belief that the decision to create a regional electric power system represents the rational solution to the energy problem. This belief assumed the status of an imperative by the mid-1970s. Faith in nuclear power and in technocratic judgement, resigned acceptance of significant cost overruns and project delays, and an abiding belief in the energy-civilization equation express some of the requirements of this technological imperative.

Autonomous Technology

Arguments of technocratic ideology and technological imperatives are at variance with most social science frameworks of explanation which tend to rely upon rationality models (Byrne, 1987). In the latter, social choice about technology is conceived as being exercised through institutions such as markets or governments independently of existing technological systems. Explanations of this type preclude the possibility of a compulsive or deterministic quality in technology choice. The contrast between conventional social science and the approach taken here can be sharply drawn through an analysis of the economic relationships underlying the WPPSS episode.

Conventional economic analysis assumes that markets act as independent arbiters of the relative worth of alternative economic activities. Through the price mechanism, competition for resources is weighed and the most efficient mix, purportedly, is accepted. The trading of current versus future goods is not supposed to affect the "independence" or the efficiency of markets (Hahn, 1981). In this view, markets are self-governed by internal rules (the laws of supply and demand) and act upon social life rather than the other way around; that is, markets are seen as autonomous institutions.

A stylized account of energy decisions in the Northwest as market-determined hardly squares with the realities of megapower. The attempt to create such an account for the WPPSS projects unavoidably devolves to a series of explanations on why market processes didn't or couldn't work. After all, the WPPSS projects represent more than $30 billion in investments (with interest) made over ten years with the only tangible result to date being several nuclear plants "left to sit out in the rain" (Gleckman, 1984: 35). But it is not simply the magnitude of the economic "mistake" that challenges the validity of conventional market doctrine. A regression analysis of bond sales during 1973-82 (the period during which the WPPSS bonds were issued) indicates that at no time did the municipal bond market, the source of capital for all five nuclear projects, assign a measurable risk premium to the WPPSS securities compared to other revenue bonds floated in the same time period. That is, the market which was responsible for financing the projects never judged them a higher risk than competing users, much less a mistake.

Table 1 summarizes the results of the analysis. (For a fuller discussion of our statistical methods and results, see our "Nuclear Optimism and the Technological Imperative", **Bulletin of Science, Technology and Society**, Forthcoming.) Our equations were successful in accounting for a large percent of the variance in interest costs paid by bond issuers. All variables used in the equation had the expected signs. While the Durbin-Watson statistics indicate that homoscedasticity cannot be assumed (and therefore that the standard errors for the equations are underestimated), this is of little relevance to our analysis. The central issue is whether a statistically distinguishable interest cost premium can be found between WPPSS and non-WPPSS issues, not whether the estimates of individuals variable effects are efficient. Using the Chow test, it can be shown that the WPPSS and non-WPPSS equations can be pooled at a 0.01 confidence level for both the quadratic and logarithm size models. Differences in interest costs are not statistically significant and can be attributed to issue size (see the intercept tests--WPPSS averaged $197 million per float while the average for revenue bonds was $85 million and the average for electric-only revenue bonds was $100 million).

These results are surprising only if a theory of autonomous markets is maintained. There are ample reasons for assuming the reverse; namely, that market activity with respect to WPPSS was conditioned by and subsumed within a political economy of megapower. Markets cannot perform a general evaluation of megapower versus other energy options because this requires an assessment of what Amory Lovins has termed institutional "architectures" which are, by their nature, mutually exclusive and antagonistic (1977:59). As he has argued, it is not possible to pursue simultaneously a centralized system of power production and exploit fully the economics of conservation and renewables. System rationality and efficiency depend upon sustained commitment to one or the other, but not both. Economic analyses of nuclear power versus other "energy paths," such as those performed by Hohmeyer (1988), Keepin and Kats (1988) and Flavin (1983 and 1989), tend not to address this point. Based on comprehensive studies of the relative social benefits and costs of full scale nuclear and conservation alternatives, these researchers conclude that nuclear power fails the market test. However, these analyses presuppose the complete replacement of one system with a different one. This would involve a comparison not only of advantages at the margin, but of mutually exclusive and antagonistic technological infrastructures. These infrastructures cannot be reduced to their "sunk costs" and, for this reason, are economic incomparables. Only one infrastructure is reflected in current investments and it is dedicated to the support of megapower. Simply put, there is a functioning system for the delivery of "parts"--from nuts and bolts to laws, financing and public policies (e.g., the Price-Anderson Act)--to service the megapower machine. There is no equivalent to service conservation and renewables.

From a megapower perspective, conservation and renewables represent enormous costs, regardless of their relative energy economy after adoption. There are the investment costs in a new infrastructure, the losses to be suffered by the old energy regime and the transition costs in smoothing the changeover. Arguments that energy is more cheaply and efficiently provided and the environment more readily protected under a conservation/renewables regime are hardly persuasive under the logic of megapower. The beneficiaries of this logic understand this all too well. That is why the U.S. Committee on Energy Awareness, a lobby for the utility industry, represents nuclear power in its media campaigns as the long-term market choice. It is, so long as the elimination of the institutional apparatus of megapower is counted as a cost (Byrne and Rich, 1983: 176-181).

Conclusion

With the WPPSS default on two plants and construction postponement of two others, it might appear that the regional autonomy of megapower has been seriously shaken. In our view, however, a negative prognosis about the future of megapower in the Pacific Northwest would be premature. Notwithstanding passage of the 1980 Pacific Northwest Power Planning and Conservation Act, which required the region to exhaust cost-effective conservation and renewable options before building additional power plants, utility commitment to megapower remains strong. Shortly after the WPPSS default, several utilities proposed construction of eight new coal and nuclear plants "while seeking to retain the option of completing...WPPSS Nuclear Units 4 and 5" (Northwest Conservation Act Coalition, 1982: 3). The 1986 Northwest Conservation and Electric Power Plan sought to extend the commitment to WNP 1 and 3 through the year 2006. Advocating a continuation of the regional cooperation pioneered under the HTPP, the Plan forecasted $2.2 billion in energy savings over the next twenty years through coordinated power development and conservation. Thirty percent of these energy savings were contingent upon the completion of WNP 1 and 3. Net benefits of $630 million were projected if the region would commit an additional $2.8 billion (not including debt service) to the WPPSS nuclear program (Northwest Power Planning Council, 1986: pp. 2-1 and 7-12). The 1986 Plan remains the controlling energy policy document for the Northwest and its objective of retaining the nuclear option was recently reaffirmed by the Northwest Power Planning Council which found that "problems precluding further financing of these plants [WNP 1 and 3] apparently have been resolved" (1989).

Nuclear power continues as a future-tense idea for progress in the region. In spite of its practical problems, megapower still represents an imperative for all technical people.

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TABLE 1
All Revenue Issues
Quadratic Model

		C	S	S^2	R	T	R^2 (Adjusted)	Chow Test	Durbin-Watson Statistics
Non-WPPSS	D	2.0163	-.1874E-5	0.6046E-11	0.4553	0.1756	0.5160		
Issues	F-value		0.966	3.435*	59.819*	573.02*			0.4666
(n = 585)	S_e		0.0000	0.0000	0.0589	0.00734			
WPPSS	D	5.5782	-.1554E-4	0.2449E-10	0.2346	0.1368	0.7268		
only	F-value		5.831*	11.302*	0.962	27.741*			1.1689
(n = 42)	S_e		0.0000	0.0000	0.2392	0.0260			
All	D	2.2412	-.2288E-5	0.8294E-11	0.4163	0.1731	0.5241	F=2.271	
Issues	F-value		1.780	10.534*	55.720*	603.32*		p=0.046	0.4720
(n = 627)	S_e	0.0000	0.0000		0.5578	0.0071			

Logarithm Model

		C	LnSize	R	T	R^2 (Adjusted)	Chow Test	Durbin-Watson Statistics
Non-WPPSS	B	1.1748	0.7054E-1	0.4555	0.1748	0.5119		
Issues	F-value		0.284	59.254*	565.977*			0.4452
(n = 585)	S_e		0.1323	0.0073	0.0073			
WPPSS	D	-4.9822	0.6516	0.4017	0.1760	0.5541		
only	F-value		2.006	1.832	32.664*			0.6224
(n = 42)	S_e		0.4600	0.2968	0.0308			
All	D	-0.3911	0.2205	0.4161	0.1743	0.5089	F=2.092	
Issues	F-value		3.290*	53.991*	595.034*		p=0.082	0.4046
(n = 627)	S_e		0.1216	0.0566	0.0071			

*Significant at the .01 level of confidence

INVENTION AND INNOVATION:

THE UNANSWERED RESEARCH QUESTIONS

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With all of our society's sophisticated technology, what remains to be invented? How about new solid waste disposal systems, drugs to cure AIDS and cocaine addiction, methods for traveling through time, and self cleaning sinks and bathtubs? The list of possible inventions is endless.

A more fundamental question is who will do the inventing? What characteristics do inventors have, and what factors foster and inhibit the process of innovation? Answers to these questions can suggest ways in which to stimulate and encourage innovation. This paper provides an overview of what scholars know about inventors and invention. It uses that overview as the basis for suggestions about possible future research to improve our understanding of innovation.

PRIOR RESEARCH

A recent U.S.Patent and Trademark Office document (1990) presents information about patent type, technology category, ownership, industry and inventor gender for patents received by U.S. residents between 1977 and 1988. About 75 percent of all patents granted were corporate owned, and only about 3.6 percent of the patents granted went to women.

A number of books explore the history of invention. Some look at the historical process of invention (Bryn, 1970; DeBono, 1974; Mumford, 1963), while others focus on a particular time period, country, or industry (Clark, 1974 and 1985; Kock, 1978). Included in this category are illustrated histories of the development of technology (The Smithsonian Institution, 1978; Williams, 1979; and Wilson, 1954). In general, this research focuses on industrial technology and attempts to analyze innovation in its environmental context. Biographies of famous inventors such as Alexander Graham Bell, Thomas Edison, Robert Fulton, and Singer are another form of historical research (Eber, 1982; Wachorst, 1981; Watts, 1985; and Brandon, 1977).

There is little detailed empirical information on the characteristics of inventors. One existing study used 45 subjects chosen randomly from the Inventors Association of New England. The findings showed that inventors were well-educated and frequently described themselves as good at problem solving and team work

(Hisrich, 1985/86). Although the sample was small, this study is an interesting beginning look at the characteristics of inventors.

Research also exists which investigates the relationship between patents and inventions and a variety of economic variables. The variables studied include the relationship between patents and of product markets (Taylor and Silberston, 1973), invention and economic growth (Schmookler, 1966), firm size, market structure and patented inventions (Scherer, 1965), and imitation costs and patents (Mansfield, Schwartz, and Wagner, 1981).
This research is empirical and it makes several important contributions to the study of invention. First, it identifies some of the difficulties in studying innovation and invention and suggests ways of handling these difficulties. These difficulties include, but are not limited to, problems in defining invention and innovation. For example, although all patented inventions are innovations, many innovations are not patented. Another problem is that only a minority of patented inventions have a significant impact on the development of technology.

POTENTIAL RESEARCH QUESTIONS

The research questions developed here are suggested beginning steps in identifying and analyzing the characteristics of inventors and innovation. The first category of questions focuses on inventors of corporately owned patents. These questions would provide information both about inventors and about the relationships between inventors and the organizations which hold title to their patents. The second category includes questions designed to provide information about the total pool of current active inventors regardless of the ownership status of their patents. The third category suggests some research topics which explore the relationship between the external legal, economic, and social climate and the inventing process.

Inventors and Corporate Owned Patents

There are a number of reasons for directing research on the innovation process at the inventors of corporately owned patents. One reason is that between 1977 and 1988 the majority of patents issued (70.6 percent) were corporately owned. Second, the importance of corporately owned patents grew during this century. At the beginning of the century independent inventors were the largest source of innovation. Historian Arthur Molella suggests that the work of early inventors "was responsible for creating the systems that would make it difficult for those of us who live later to be as free in our creative activity (1989)." In other words, as technology develops and becomes increasingly complex, increments to that technology must build on what exists and also be sophisticated.

In our society the major determinants of what technologies win acceptance and prosper are supply and demand market forces. There are some exceptions such as national defense systems. Generally, however, the acid tests for new technologies are whether private companies choose to market them and whether they gain marketplace success. Given the inherent problems in bringing new products to market, it is probably reasonable to assume that corporate owned patents have a higher market success rate than do independently owned patents.

If one assumes that the inventors of corporately owned patents will continue to be of importance, a number of potentially rewarding research topics can be identified. Some of the topics involve the characteristics of the individual inventors. Other topics involve relationships between corporations and inventors.

There is little published information on the characteristics of inventors generally, or corporate inventors specifically. A useful beginning research agenda would involve the development of a data base providing basic demographic data such as age, education, occupation, race, gender and employment experience. This information could be supplemented by information on family background, hobbies, personal experiences which led to an interest in invention, perceived rewards of inventing, and the patent experience of individual inventors.

Another area of potential research involves the relationship between corporations and inventors. This topic encompasses a variety of topics related to recruiting, selection, training and development, motivation, and compensation.

How do organizations recruit potential inventors? Are there certain sources which serve as a consistent supply of creative people? Are potential inventors told when they are recruited that innovation and invention are expected of them? If invention is important to an organization, how are inventors identified and what selection standards are used in the staffing process?

Another set of interesting questions could be designed to look at what happens to potential inventors once they become employees of the organization. How are the goals and norms of the organization communicated? Are they assigned mentors? What other forms of training and development does the organization provide?

And finally, how are contributions of individual inventors evaluated and rewards distributed? Are patents sufficient evidence of successful job performance, or does the patent have to be developed into a product before it is seen as a success?
If the patent is the result of a group effort, do all members of the group share equally in the rewards? Are there rewards provided other than monetary rewards? Do the inventors see the rewards as important motivators?

These are not new research questions. They have all been the focus of much research involving a wide variety of organizations and many different employees. Although these studies have not focused on inventors, they can provide both theoretical frameworks and empirical findings for comparisons with inventors.

Another advantage of focusing on corporate inventors is that it is possible to get a large amount of rich background information from the human resource administration departments in those companies. Typically these companies are willing to share with researchers information such as recruiting, selection, training, and compensation practices. These people can also serve as an access conduit.

Independent Inventors

Although most patents are assigned to corporations, in every year since 1977 between 9,000 and 13,000 patents were awarded to independent inventors. As with corporate inventors, little is known about independent inventors.

The study of 45 New England inventors discussed earlier suggests many interesting research topics including the demographic characteristics of inventors, how inventors perceive themselves and the inventing process, and the differences between successful and unsuccessful inventors (Hisrich, 1985/86). It also suggests a way around one of the thorny methodological problems confronting scholars interested in independent inventors, the identification of successful active inventors.

Most patents do not become commercially successful. Therefore, selecting names randomly from patent records will provide a large number of inventors whose ideas were not developed. There is interesting information to be gotten from these inventors, of course, including demographic information and the barriers faced in marketing inventions. However, using the membership of inventor associations, as Hisrich did, is likely to increase the percentage of successful inventors sampled.

The External Environment

The legal environment surrounding the protection of intellectual property underwent radical change during the 1980s. Since 1983 Congress enacted 14 laws strengthening intellectual property protection. The full impact of these laws is not yet clear. However, these laws and the 1982 creation of the U.S. Court of Appeals for the Federal Circuit in Washington as a last resort for patent cases appeared to increase patent litigation enormously. Sixty percent more patent cases were filed in 1988 than in 1980, and the legal pendulum appeared to have been favoring patent holders (Business Week, 1989).

This development is particularly interesting given the findings of a 1980 study of patent imitations. That study found that 60 percent of all successful patented inventions were imitated within 4 years, thus limiting the importance of patent protections (Mansfield, Schwartz, and Wagner). Clearly this would be a good time to replicate that study to determine if recent changes in patent policy decreased imitations and increased the importance of patent protection.

If policy changes increase patent profitability, theoretically the incentives for both corporations and individuals to patent inventions will increase. If the rate of patent activity increases, it would suggest that a major determinant of patent numbers is their legal status.

In addition to changes in the legal environment, changes in our society's educational climate may also be critical to encouraging innovation. For example, Donald Quigg, former Commissioner of the U.S. Patent and Trademark Office, stated, "It is a widely shared opinion that Americans are not as inventive as they once were. Such opinions can be debated, but virtually everyone would agree that we are becoming a nation of buyers rather than suppliers of new technology" (Reynolds, 1989). He advocated a variety of remedies, including creativity programs and inventor fairs. An example of one of these efforts is Project XL, a program the Patent Office is promoting which to encourages a variety of creative thinking courses and programs in local schools (Reynolds, 1989).

The long run contributions of such programs to innovation is another possible research topic. Who teaches these courses? Are the teachers trained in the scientific process, or are they people with marginal technical skills hired primarily because of institutional cost constraints? Do inventor fairs and creativity classes for children foster invention? Or do they divert resources, energy and attention away from developing the fundamental mathematics and science skills necessary to invent in a technological society.

A 1989 standardized mathematics exam given to children from six countries suggests these programs should be evaluated carefully. Korean children scored highest, while Americans scored lowest, behind Spain, Britain, Ireland and Canada. Even more shocking, 68 percent of these American students agreed with the statement, "I am good at mathematics." Only 23 percent of the Koreans answered yes. As one commentator suggested, "American students may not know their math, but they have evidently absorbed the lessons of the newly fashioned self-esteem curriculum wherein kids are taught to feel good about themselves" (Krauthammer, 1990).

Most educators would agree that self-esteem can have a positive effect on academic success. However, efforts which focus on making students "feel" competent may not have the desired impact if they create the illusion of competence without accompanying skills. Most innovation is a variation on an existing theme. This suggests that inventor fairs, creativity classes for children and similar efforts to encourage inventiveness are probably misguided and perhaps useless and self-defeating unless they are carefully tied to programs helping students master the existing themes.

Conclusions

There are many interesting questions to be asked about inventors and inventions which can help provide information about how to encourage innovation. Some of these questions involve the inventors themselves. What are they like? What makes them invent? Related questions can explore what companies do to encourage innovation. What relationships between corporations and inventors have a positive impact on the invention process?

Other research can investigate the relationship between innovation and the external environment. How does patent policy affect the rewards resulting from invention? And, if so, will changes in patent policy make up for, at least in the short run, our society's inadequate support for science and mathematics education?

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Underrepresented Minorities in Science and Technology

ETHICS AND VALUES IN SCIENCE AND TECHNOLOGY: A MEXICAN-AMERICAN PERSPECTIVE

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Reflection on the limited involvement of the Mexican-American community in the nation's science and technology effort, conjures a vision of two immiscible fluids, co-existing, touching one another with some but very little mixing. Further observation shows that the ingredients responsible for the immiscibility are culture dependent. One, as I, who moves with less than total freedom between the two fluids, can assess not only the unfortunate loss created by this condition but also the irrationality of its existence. The situation is further exacerbated when one realizes that this country, more than ever, needs to utilize its human resources with increasing efficiency to remain competitive.

The case examined here has merit in improving exchange among cultures in general. I believe that assessing the consequences of the clash between two culturally identifiable groups in the U.S. will improve our dealing with other world cultures. For it my premise that harmonious living, a measure of a desired quality of life, depends on people harboring similar cultural values or respect for dissimilar ones. Moreover, the endurance of a nation depends upon the maintenance and display of mutual respect for the different cultures represented among its citizens. Translated to the world at large, this respect will also determine the viability of one nation among others.

How badly do those Americans making a livelihood in science and technology need to consider this topic? In a recent one page article by Bruce Stokes (1989), he refers to two recently published works concerned with the imbalance of U.S. trade with Japan, (Is there any doubt of the role of science and technology in the trade with Japan?) he states, "(two authors argued recently) that Japanese society lacks the Western heritage of universal values-such as a concept of absolute truth and a commitment to the rights of the individual...lacking such Western-style values, the Japanese have no values at all and thus are somehow inferior to Westerners."

To me, it is unbelievable that this statement was made in this century let alone this past year! The view expressed is remindful of the account given by Boorstin (1983) on how Europeans argued furiously beginning 400 years ago whether Native Americans were members of the human race. I cannot see how the U.S. can remain competitive if views like those expressed above on Japanese values remain in our minds. Putting down values is not a way to compete. Cultural values are not fadish that change with the weather but are almost a genetic imprint; so much so that changes in values require a time scale marked off in generations. They deserve the most serious consideration.

Being a Natural Scientist and member of the Hispanic-American community, this article shows in part that this community recognizes the need to assess its ethics and values as it concerns science and technology. To be sure, the behavorial science research useful to understand relevant ethics and values of the various Hispanic-American subgroups is not available to the best of my knowledge. However, I would suggest that two characteristics applicable to Hispanic-Americans in general figure prominently in such a behavorial study. One concerns respect for law and order and the other, love of family. I would not be surprised to learn that the former characteristic would in some way show that Hispanic-Americans have strong apprehensions about the science and technology that interferes and interrupts the order in the natural environment.

As with Native Americans, Hispanic-Americans have a great deal of respect for how nature has assisted their survival. The land was quite yielding to them, providing ample wild game and abundant plant and mineral resources to sustain them. It was a source of medicinal remedies that today still figure in their everyday living. I have always wondered if the combination of respect for law and order and the love of family would explain why such a high number of Hispanic-Americans have been recipients of the Congressional Medal of Honor, relative to their proportion in the U.S. population.

Of the other characteristic, love of family, I would not be surprised if that value were strongly correlated to the belief that survival of the group is of higher priority than survival of the individual. Thus, one would have to wonder if the individual competitiveness associated with great triumphs in science and technology is a trait subordinated among the values held by this community. Absent the individuality that typifies the accomplishments of great scientists and engineers with the long periods of isolation and contemplation it demands, Hispanic-Americans may not be prone to make the implied personal sacrifices. It would be interesting to learn if having greater socio-economic security, Hispanic-Americans would tend to be more competitive individually and thereby lead to their increased participation in science and technology.

It is my view that the absence of an appropriate infrastructure within the Mexican-American community is a principal factor in its inability to engage more completely in science and technology. By *infrastructure I mean foremost* a communication system that allows rapid dissemination of information and has a feedback mechanism appropriate for fromulating a community consensus on critical issues. It would include a means to effectively influence formal education of its members. It would include having an apparatus controlled by the Hispanic-American community to provide for continuing education of its members with a special orientation to develop and enhance civic leadership. It would include a means to gather, select and maintain current, accurate and complete information on the extent and type of human resources available within the community. It would incorporate means to ensure the community infrastructure interfaces actively with the national one for mutual benefit.

A well established infrastructure would be able to document and readily provide historical accounts of particular interest to serve Mexican-Americans and reveal evolution of their community. The accounts would assist members to become well versed in the roles the community played in the development of agriculture, mining, transportation, lumber and steel industries in this country. It would also document the role Mexican-Americans played in national defense and how Mexican-Americans established a presence in professions accessed through rigorous formal education. If such information is easily available, it isn't easy to locate as a search at the Library of Congress will verify. The lack of this history, I believe, seriously hinders Mexican-Americans from establishing the strong emotional attraction, the spirit of citizenship, to contribute in a more wholesome manner to strenghtening the nation's posture.

Without such a viable infrastructure, the Mexican-American community will not attain a science literacy and an appreciation of technology to establish an *equitable presence in these areas. The great importance of science and* technology in our everyday lives makes it imperative that if this community is going to be counted on to assist this country remain competitive with the rest of the world, means should be made to make science and technology easily accessible that community. Without intervention, the potential asset of this community's involvement will become a liability, not a null as some would have one believe.

Years of discrimination made greatly hindered the Mexican-Americans in establishing an adequate communication system. Instituting an appropriate communication system would not only facilitate delivery of relevant information but it would assist development within Mexican-Americans to interpret and understand the information transmitted. It is to be noted in particular that discrimination took a great toll on the language fluency of Mexican-Americans. At the same time it gave rise to a distrust of those institutions built with a Eurocentric cultural content and designed to provide services to the community. The distrust and lack of language fluency both exist today.

Formal education attempted to teach Mexican-Americans a language whose learning was not re-enforced by parents at home. Not only did the parents not know the English language but they were not particularly anxious to have one of their strongest cultural traits replaced. As a result, neither language-Spanish or English-was mastered well enough by most Mexican-American students by the time they were old enough to discontinue their formal education. In general, the lack of fluency in a language among Mexican-Americans remains a handicap. It is worth reminding ourselves that understanding science and technology requires a strong command of a language, a fact that is not appreciated by those who have not *experienced the lack of it.*

Thus, when asked by a very conscientious and well meaning science organization to review a pamphlet it produced for Hispanic-American parents to assist them in channeling their children to pursue studies in mathematics, I responded by saying that if the parents I am concerned about could read the pamphlet, either in English or Spanish, there would not be a need for the pamphlet. The point being that any parent having sufficient command of either Spanish or English to understand the pamphlet's message would already have channeled the child appropriately. Hispanic-American parents appear to have an almost divine respect for wisdom, knowledge and education. I doubt if, with proper counseling, it would take much prompting to obtain their steadfast cooperation to support education.

Mexican-Americans do not have the direction and the depth of leadership necessary nor the means to establish the communication infrastructure urged above. They do not control the schools their children attend nor do they have sufficient presence in their operation to affect direction. If truth be known, they probably do not understand sufficiently well the process by which changes in schools can be effected. Mexican-Americans are very apolitical. I wouldn't be surprised to learn they have the largest non-voting fraction of any U.S. born ethnic community. It would be interesting to learn if the condition stems from their perceiving that results of their voting have been frustrated over the years by gerrymandering. Their recognition of this distortion was most likely associated as a cultural trait of the people that introduced the electoral process, i.e., that the Eurocentric culture is not satisfied unless it holds a dominant position in whatever society it happens to be present. While a number of minor publications target the Hispanic community in the U.S., there does not appear to be one major publication, either newspaper or magazine, that reaches the Hispanic reading public in a significant proportion. Mexican-Americans, while espousing the Roman Catholic religion principally, have little if any say on the socializing aims and methods of that institution. It by itself cannot be used to institute the necessary changes.

Other national institutions that have the mandate to deliver the services to assimilate the Mexican-American community do not have the proper disposition to do so. These institutions were founded very early in U.S. history when the Eurocentric culture was the sole arbitrator of what was worth delivering. Over the years, the institutions achieved results that affirmed the effectiveness of their strategies and directions. The thought never appears to been considered by these institutions that the cultural makeup of American society would change significantly. For if the thought did occur, some strategy would have been incorporated into the institutional framework that would have taken into account societal changes and ascertained all Amricans would be provided services in an equitable fashion. That did not happen. Instead, these institutions developed peripheral activities, notably "minority programs", to deal with the diversification of the cultural makeup of American society. I wonder how long these institutions plan to maintain their minority programs. (Shouldn't there be a plan on how activities to be achieved under these sheltered programs are going to be integrated into the overall scheme of things?) In addition, if one studies these institutions and examines the personnel makeup of those that influence hiring decisions, design program contents, and formulate budgets, etc., one sees a decided absence of non-Eurocentric community members. One must ask, "How national are these national institutions?". That Americans of other cultures qualified to serve in strategic positions within these institutions are not available is no longer a suitable response, if it ever was. That notion has been addressed adequately and it does not stand.

In summary, two conditions are considered key to the appropriate participation of Mexican-Americans in science and technology. One is establishment of an effective infrastructure within this community and the second is a response by national institutions to the changing demographics and cultural makeup of American society by incorporating Mexican-Americans as full partners. Satisfying these conditions will reveal the attainment of mutual respect among the cultures involved. Importantly, this development would be an affirmation of respect for cultures in general, a respect that is the key to our nation's more effective dealings with other nations.

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"WOMEN IN A TECHNOLOGICAL WORLD": AN INTERDISCIPLINARY CORE COURSE AT EMMANUEL COLLEGE IN BOSTON

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Historically women have had a different connection with technology than men. In many instances our contributions have been ignored, erased, trivialized, and coopted. In other instances we have been excluded from full participation in the design and development of technologies, falling instead into the realm of users and/or consumers of "technological advances." In pursuit of these advances, we sometimes have been exploited as cheap labor in factories and fields around the globe. Ignorant, mystified, overwhelmed, threatened, bored by the seeming incomprehensibility and remoteness of "technology," many women have not recognized and/or have not questioned our marginal presence in the world of technology. As the title of the course implied, one of our goals was to situate women in the global context of a world increasingly characterized by sophisticated technologies and to project a future of active participation of women in technological decision-making and implementation based on our knowledge, skills in critical thinking and self confidence.

Another major goal was to shake technology out of the realm of the reified and to cast it as a set of human activities (not just particular processes or products) which have social, political, economic and environmental consequences around the globe. We wanted to show that technology is ladened with choices and that behind those choices lie values. Consequently all technologies are subject to critical assessment and in fact, as citizens in a technological world, it is our responsibility to be aware of technological developments, to be able to perform technological assessments and to follow through with appropriate action.

To this end we designed the course "Women in a Technological World," which was presented by a four-women interdisciplinary teaching team comprised of a biologist, a psychologist, a religious studies specialist, and a sociologist in the fall of the 1989-90 academic year. As a course being piloted as a junior core requirement it drew 75 students. This is a very large number by the standards of our college. Emmanuel College is a Catholic liberal arts college for women in Boston with a total enrollment of about 800 students of whom somewhat fewer than 600 are traditional undergraduates. Over 20 percent are minority and foreign students.

The course focused on how women are globally connected through experiences with technology. The specific topics covered were:

1. Computers--development of microchips, conditions of production and the computer culture;
2. World Hunger--social, political and economic factors in world agriculture;
3. Reproductive Technologies--covering birth control as well as fertility techniques and their differential applications worldwide;
4. Solid Waste Disposal--landfills, incinerators, recycling and their environmental consequences with special attention given to the production of plastics and their disposal in oceans.

In all cases we looked closely at the roles of women, at the values implicit in the use of the technology, and at the skills students could develop by doing a technological assessment.

A prominent feature of the course was the work of 20 different project teams of three to five students. The research often included site visits and interviews with specialists. Each team presented its project at a "Women and Technology Fair" which was held for two days at the college. Open to the public and visited by students, faculty, staff and trustees the Fair turned into an event of celebration and pride. The exhibits included imaginative visual displays, a paper detailing their results, and members of each team present to explain their projects. It was a first-of-its-kind event which was talked about for days.

There are many lessons to be learned from this experience. We wish to address three:
(1) The process of overcoming obstacles and establishing technology awareness as a legitimate subject in a liberal arts college;
(2) the impact of the process of developing and teaching "Women in a Technological World" on the four faculty members involved and on the intellectual life of the college;
(3) the impact of the course on the first class of students exposed to it and the lessons to be learned from that experience.

(1) Overcoming Resistance. How did we win the faculty over to allowing technology into the core curriculum? After all C.P.Snow's "Two Cultures" are still generally kept quite separate in most liberal arts colleges, ours not excluded. It wasn't easy and it still required a partial, compromise approach. After at first having been promised to teach the junior core course there was an outcry from some of the humanities faculty that this smacked of monopoly. Could other team-taught courses not also fulfill the newly introduced requirement.? So the students were given a choice but enrollments in this course skyrocketed.

The opposition of the faculty to the course might well have been even greater if there had not already been some effort at bringing technology into the curriculum. The sociologist on the team had, under an earlier grant from the Council of Independent Colleges in 1985-86 ,organized a year-long, six-part lecture series "Technology and the Transformation of Urban Life" at the same time as she introduced a highly successful, albeit elective, course "The City," taught by her and an historian.

This course, now in its fifth year and most of the time with record enrollments, contains a strong technological field-work component requiring teams of students to study a major urban engineering project: the transportation system; clean water and waste systems; or architecture/construction. The quality of student presentations, including imaginative visual displays and explanations of engineering principles, has generally surpassed our expectations and convinced us of the importance of hands-on independent research and interviews with engineers and planners by groups of students. Confidence, competence and responsibility were some of the notable byproducts of this process. This approach became the model for the team projects of "Women in a Technological World" and it was the most successful aspect of the course.

However much "The City" was a fixture on campus for some years, it was not until the "Women and Technology Fair" that the faculty of Emmanuel College could really appreciate how much of an essentially human activity technology is and how empowering it is to women students in particular to overcome their fears of things technical.

(2) Impact on the Four Faculty Involved. The range of technologies in "Women in a Technological World" was broader and more ambitious, but in the year and a half we allotted to the preparation of the course as a study group, meeting on a regular basis, the four women in the group engaged in much more than acquiring some working knowledge of specific technologies.

Coming together, each with a certain amount of residual stereotyping about the other's disciplines, and each with a different conception about what it meant to speak of women in global perspective, we soon were probing each other's philosophies of life, approaches to education, and type of feminist analysis. We found each other wanting at times. Suspicion and holding back were not unknown to us. Discussions became quite heated at times over whether a particular text we had selected for study, such as Arnold Pacey's *The Culture of Technology* , was anti-science or weak on women's issues.

Surprisingly, and actually much more implicitly than explicitly, we had agreement from the outset on our styles of working together. We were cooperative and supportive rather than competitive; we were generous with our disciplinary turf (e.g. the sociologist rather than the theologian addressed value issues in the computer culture; the biologist lectured on the social and political causes of world hunger; the theologian explained computer chips; and the psychologist waxed eloquent on plastics). Above all we were committed to creating an integrated course rather than a smorgasboard of unrelated issues. And yet we had to confront the question of which finite, small number of issues to select. Criteria in addition to integration had to be brought into play: What are important technologies with clear impacts on women worldwide? For which of these technologies will our students find resources for research? In which areas of technology do the faculty members' expertise lie? And most importantly which areas draw the most faculty enthusiasm?

It may be a truism, but one worth passing on where the teaching of technology to non-technologists is concerned: faculty passion and excitement about specific technologies must be evident to students. In our case faculty interest and commitment generated the subjects of computers, world hunger, reproductive technologies, and plastics. They were important and they satisfied the requirement that they have global implications, but other topics could be substituted should there be a change in personnel. This gives the team-taught course a certain amount of flexibility. For the students the lessons learned from the research on a particular technology can be transferred to other technological issues and devices when the need arises.

For the four of us who worked on "Women in a Technological World," the process of preparation and teaching has been a great practical and intellectual experience, something that is inordinately valuable and needed in a small teaching institution. Teaching the course once has also created a whole other continuing agenda: how we can improve our understanding of technology? How can we better deal with the gender-specific nature of scientific knowledge production and engineering practice? How can we further refine our feminist analysis and ecological awareness?

(3) Impact on Students. Overwhelmingly students considered the readings, lectures, discussions and projects enlightening. They most often commented in the course evaluations given at the end that they now are knowledgeable about issues that they were not even aware of or interested in before (e.g. plastics in the ocean; exploitation of women in Third World countries by the garment and electronics industries). They commented that they now see as very important, issues they would never have chosen to study. In fact, by the end of the course a good many students expressed interest in plastics and waste disposal--topics that had bored them before.

Originally seeing technology and certain technological problems as outside their world and unrelated to their lives, they now see how their lives are directly affected by technology (greenhouse effect, depletion of ozone layer) and how their habits and use of certain technologies/products directly affect others and the environment (destruction of rainforests for hamburgers, threat of excessive plastic packaging to the environment). One student wrote, "I never really understood the ramifications of living in a technological world, but now I know about multinationals and life in Silicon Valley." They claimed a loss of naiveté and a new level of sophistication, which transformed their understanding of current events. Students not only became more technologically literate, but they also experienced a transformation of consciousness and a sense of interconnectedness with women in Third World countries and the impact of technology on their struggle to survive (e.g. Green Revolution and electronics industry). An even greater number cited their newly acquired knowledge of and sensitivity to the environmental consequences of particular technologies as a very beneficial aspect of the course (e.g. the manufacturing processes of plastics).

We think that these effects occurred because we consistently applied an equity-based technological assessment model to each topic. This model which was introduced at the very beginning of the course, provides specific guidelines along which to evaluate a technology in the four contexts of (1) development, (2) use, (3) social impacts and (4) environmental impacts. Central to it is an evaluation of the cost and benefits to everyone and everything, including animals and the Earth, affected by the emergence and implementation of a particular technology.

The students spontaneously expressed horror and rage after many of the factual presentations that were part of the technological assessments (e.g. the agonizing deaths of marine animals entrapped in plastic in the ocean, or the political and economic causes (not agricultural) of world hunger, or the physical and emotional damage endured by women who produce computer microchips in "clean rooms"). This comprehensive, value-explicit technological assessment engaged the whole student (thinking, feeling, acting) and generated some of the other changes we will now discuss.

The majority of students reported that they felt personally empowered by their experience in the course and confident that they can make a difference, that they can bring about change in the world. Many spoke of being able to "pass it on" by talking with and educating others. Students wrote, "I've learned how to be informed. I cannot just sit back and hope to see something on the news." and another, "This course, above all, taught me to stand up for many environmental issues I believe in and issues in general."

They came to recognize how deeply involved our daily lives are in a myriad of technologies--some of which have seriously harmful consequences--and they were spurred to action. In a brainstorming session during the last class, they generated a long list of strategies they now employ or intend to adopt to affect change in some of the problem areas defined by this course. Some examples: run for town committee, use alternatives to harmful chemicals in the household, learn how to use a computer, remain a vegetarian, reuse plastic bags and cut six-pack rings. And virtually every student indicated on the course evaluation that she felt confident and more prepared to take an active role in her community on technology-related issues. Some students acknowledged that this course changed the way they would approach their careers. For example a doctor-to-be envisioned herself being more open-minded; a prospective teacher looks forward to including selected topics in her lesson plans to educate the young, to keep awareness and change happening.

The most direct and immediate expression of this newly-kindled desire to effect change was the number of exhibits at the "Women and Technology Fair" which contained an action component: project teams had petitions to sign, literature on how to join various environmental and reproductive rights groups, information about organiztions to call or write to become involved in direct action, etc.

For the students the highlight of the course was the common display of their 20 different team projects at the Fair. They pointed out how much more knowledge they derived from working with others rather than alone; how interesting it was to learn the different views and perspectives of others and to be considerate of those differences. They learned to deal better with people in a work situation and to cooperate even when under great stress. Group work generated a heightened sense of personal responsiblity in some and was the occasion for them to gain respect for the knowledge and views of their teammembers. The field work, site visit, interview component of the project was valued by many for putting them in touch with new people and concretizing what they read and heard in class.

Pride and excitement were almost palpable in the hall the day and night of the "Women and Technology Fair." They did it! And they did it well--on the whole. Many gained self-confidence and personal satisfaction from explaining their projects to the faculty in the course and then to the attending college community. One visiting science faculty member said, "I hate science fairs, but this is wonderful, because it includes the social, political and economic ramifications of technology."

By working on the projects the students acquired in-depth knowledge of specific technologies. Their on-site, first-hand investigations of the techniques and processes and/or their personal interviews demystified previously obscure and remote areas of technology. Also students were able in the projects to express proficiency with course material other than on traditional midterm and final examinations.

Lest you imagine that this course ran without snags or conflict, let us assure you that it had a number of serious ones. For example, the scope of the course and our goals were very ambitious, at the same time the course was a requirement and dealt with subject matter with which they were neither familiar nor comfortable. Consequently by midterm time their resistance and high levels of anxiety were reflected in a midterm course evaluation. We decided to reduce the readings and assignments for the remainder of the course. It worked and resentment dwindled.

Another area of contention arose around the introduction of ecofeminism at the onset of the course. Ecofeminism is a blending of the principles and goals of feminism and the science of ecology. Although there were some students who were excited and challenged by the perspective, it is fair to say that many were angry and resentful, hostile and resistant to the approach. This was manifested most directly in comments such as, "they were trying to force feminism down our throats" and "She [the lecturer] is a man-hater." The hostility and resistance we encountered in these students will be familiar to many of you who have taught courses from or including the feminist perspective. These students are terrified to make connections that could shatter the fragile stability of their worlds--a stability based on the stereotypes that . . . "things are better for women"; "it couldn't happen to me"; or "women get what they deserve." These women sense the challenge to women embedded in feminism to unthink and unfeel and undo male-identification and to create a woman-identification based on female bonding. We also feel that the intense fear elicited by the mere speaking of the feminist perspective is the result of internalized rage at the systematic oppression of women, animals and the Earth--a rage, that if felt, would catapult them into radical change.

By the end of the course, the most outspoken of the students were acknowledging that there were some good points to it after all. We are not saying the students became staunch feminists; rather we think they made connections between the principles of ecofeminism and knowledge of the ecological/environmental devastation which emerged from some of the technological assessments conducted in the course.

A final impressive change we noted in the students was around their original expectations of the course. A number of students entered the course thinking we were going to teach them how to "make it" in a technological world; how to succeed, compete, advance and manage a family. As you can imagine from this brief presentation, they were keenly disappointed. Nonetheless, this complaint which made it into the midterm course evaluations, did not at all resurface on the final course evaluation. By the end of the course the students were very aware of the value of our approach. They had experienced the personal power derived from knowing and understanding what previously was mystifying and intimidating. They experienced the excitement of making connections between their lives and technologies, their futures and technology. They were enthusiastic about the expansion of their consciousness and caring about women and men in Third World countries, animals, and the Earth. Politics, economics and global affairs became topics of interest. They experienced deep satisfaction from their successful performances at the Fair. They knew the joy of joining with peers on a common task and overcoming obstacles while maintaining mutual respect. We believe that on the final course evaluations they were telling us that what they really got from participating in the course far exceeded their original expectations.

We are encouraged by the results and are eager to take what we have learned from our successes and mistakes and present an improved version of the course next year. We also plan to elicit one or two more times by questionnaire the longterm impact of the course, for we believe it is one of those learning experiences the benefits of which often manifest themselves increasingly as some time for action and reflection has passed.

Copies of the complete syllabus can be obtained from the authors.
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Required Books: **Scientific American,** September 1989 issue

Joan Rothschild (ed.) ***Machina ex Dea***
Barbara Ehrenreich and Annette Fuentes ***Women in the Global Factory***
Dennis Hayes ***Behind the Silicon Curtain***
Frances Lappé , ***World Hunger: Twelve Myths***
Frances Moore Lappé and Rachel Shurman ***The Missing Piece in the Population Puzzle***
Center for Environmental Education ***A Citizens' Guide to Plastics in the Ocean***
Concern, Inc. ***Waste: Choices for Communities***
Mass PIRG ***Up in Smoke***

List of projects offered. Asterisk indicates project chosen and displayed at Fair:

1. The Automated Office and Office Politics
2. Visual Display Terminals and their Hazards
3. How Men and Women Relate to Computers
4.* The Destruction of the Rainforests
5.* Science and Technology in the Media. (This team also does media work for the Fair)
6. Trace the Solid Waste Stream at Emmanuel and Devise a Recycling Project for the Campus.
7. Critical Assessment of Solid Waste Disposal Systems in Two Local Towns
8. An Equity Analysis of a Production Facility in the Boston Area
9.* Compare the Degree and Type of Beach Pollution of Several Area Beaches
10. The International Recycling Trade (scrap metal, rags, etc.)
11. Biodegradable Plastics
12.* What Happened to the Milkman : From Glass Bottles to Plastic and Paper Containers
13.* Plastics as a Medium in Art. (This project includes design of the Fair exhibits.)
14. Historical Analysis of Food Containers
15.* What Do we Put on Our Faces? The Technology of Cosmetics
16. Paper Production : Historic Changes and Ecological Impact
17.* Book and Document Preservation and Restoration Technology
18.* Animal Testing of New Technologies
19. What Happens when Fashions Change from Synthetic Fibers to Natural Fibers and back again?
20.* Mudslinging : The Massachusetts Water Resources Authority (MWRA) and the disposal of Sludge

21.* The Exxon Valdez Oil Spill and the Rhode Island Oil Spill
22.* The Boston Harbor Clean-up
23.* Farmworkers and Consumers: The Case of Pesticides on Fruit and Vegetables
24.* Women, Corporations and Baby Formula
25. Sugar
26.* Rice Cultures
27. An Apple a Day Keeps the Doctor Away?
28. Seeds: The Green Revolution in Nicaragua
29.* Premature Infants and Neonatal Technology
30.* Prediction and Intervention in Pregnancy
31.* Reproductive Technologies
32.* Research and Community Involvement: The Case of AIDS
33.* Genetic Engineering in Medicine
34. Safe Air Travel vs. Corporate Profits: What is Required to Put Safe Airplanes into the Sky?
35.* Twentieth Century Changes in Household Technology

REMOVING THE ROSE-COLORED GLASSES:
An exploration of education in Newark, an urban multicultural setting

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New Jersey Institute of Technology (NJIT) has a special mission because of its location in a metropolitan area and the diversity of its ethnic population. In fact, the school has the highest percentage of foreign students of all institutions of higher learning in the country, as well as a student body reflecting the population of Newark and the surrounding area. In an attempt to take advantage of the special responsibilities and opportunities that its location and heterogeneity afford it, NJIT has instituted several successful, ongoing programs.

In the mid-sixties Newark College of Engineering (NCE), as NJIT was then known, existed as an island in Newark, the largest city in New Jersey. On one side was the downtown shopping and business district. The other three sides were formed by the mostly minority and mostly impoverished people living in that area of the city. The ethnic composition of this area included African Americans, Hispanics, Portuguese, and Asians. White students and faculty in their jackets and ties (NCE had a dress code then) traveled from the suburbs into Newark at the beginning of classes and then out of Newark when the class day was done. It was impossible to make this trek without passing through the area where the local residents lived, yet there was no cognizance of their poor living conditions.

Then in the hot summer of 1967 the Newark riots erupted with such tremendous force that it blew the rose-colored glasses, not only from the eyes of NCE, but also from the eyes of New Jersey state officials. It was realized very quickly that one important ingredient necessary for resolving the racial turmoil was education: education of minorities to attain equal status in the workplace and education of whites to gain awareness of the community surrounding the Institute. Thus, the **Educational Opportunities Fund (EOF)** was born one year later, as the State of New Jersey allocated significant funds to increase the number of minority students in higher education.

Prior to the institution of EOF, NCE had virtually no minorities on campus. Now, the one hundred and twenty five **Educational Opportunity Program (EOP)** students entering NJIT each year make up about 20% of each freshman class. Moreover, NJIT is ranked in the top 10 % in the nation in graduating minority engineers, a statistic in which the NJIT administration takes much pride.

In the early seventies, recognition that the campus was underutilized in the summer led to the development of what became the current Center for Pre-College Programs. Now this Center, numbering over twenty programs, including **Urban Engineering**, introduces junior and senior high school students to opportunities in a technical college. This summer program of six weeks for high school students and four weeks for junior high school youngsters identifies minority students with an interest and aptitude in science and mathematics. Science laboratories, engineering design exercises and presentations as well as career counseling encourages the youngsters to pursue goals in technological areas. The curriculum includes instruction in water resources and wastewater disposal, transportation systems, energy resources and generation, architectural design, and urban planning, in addition to reinforcement and enrichment in mathematics, science, computer science, and communications.

Recognizing that very few young women participated in these programs, **Females in Engineering ... Methods, Motivation, Experience (FEMME)** was developed in 1981 to encourage young women to pursue technological professions. The aim of this summer program is to encourage young ninth grade women to take advanced courses in mathematics and science and to consider careers in technical fields. Activities are designed to introduce these students to opportunities in science and engineering, to provide hands-on laboratory experiences, to foster a cooperative spirit and to engender an appreciation of the fragility of the environment.

In the summer of 1986, the first **Science and Mathematics Enrichment for the Disabled (SMED)** program, funded by the New Jersey Department of Education (DHE), was held at NJIT. The five week summer program, which included science, mathematics, computers, along with career and personal exploration, provided disabled junior high school students with exposure to technical career options and the skills needed for success in technological fields. Similar SMED programs were funded by DHE at NJIT in 1987, 1988 and 1989. In 1990 and 1991, SMED at NJIT will be funded by the National Science Foundation (NSF). Students of average or superior intelligence selected for these programs have a variety of learning disabilities and physical disabilities, including mobility impairments, visual impairments, chronic illnesses and profound deafness. Because of the poor quality of science, math and technology education often received by disabled students, the SMED program was designed to fill a gap. Each year that it was funded, SMED improved. The evaluator required by the state described SMED as "very important" and "innovative."

Other programs for underrepresented populations are concentrated in specific disciplines such as **ChIME(Chemical Industry for Minorities in Engineering)**, Computer Based Physics, and **National Science Foundation Young Scholars** which focuses on Environmental Engineering. These programs are constantly being revised to make them accessible to an increasing variety of students. The multi-cultural demography of the student body of NJIT is enhanced by the pre-college efforts

This rich cultural mix presents NJIT with challenges, not peculiar to this institution, as well as means for reconciling potential conflict. For example, when a student made reference to a mugging he had experienced in his hometown, this question was raised in a humanities class as if it were a legitimate query: "Could it be that the increased violence apparent in our daily lives is caused by one bad race?" In addition, students demonstrated lack of historical perspective by asking, "Why is there a Negro College Fund and a National Association for the Advancement of Colored People when it would be considered racist to have a White College Fund and a National Association for the Advancement of White People?" When assigned a critical essay on Social Darwinism, which included the selection, "Man Must Kill," by Hitler, too many students merely reiterated Hitlers's views, finding them, for the most part, acceptable. Some felt his goal of racial purity was good, but his methods were reprehensible; others thought the only problem was that he sought to implement his fine racial theory too quickly.

One way of neutralizing the potentially insidious *naivete* of these students, as well as bringing the discussion back to the course material--in this case the history of ideas in Western culture--was to pose questions, such as, "How would Locke or Rousseau view the reasons for the behavior of the student's assailant?" Yet, by far, it was the so-called disadvantaged minority students, who served as the most effective antidote, balancing the excesses of their peers who were less sensitive to the dangerous implications of charged language connoting bigotry and the twisted values intrinsic to eugenics.

Conveniently, it is Nazi Germany that provides a terrifying picture of the dangers inherent in a technological education devoid of humanistic values. It is not enough that students graduate having acquired expertise in technological subjects. It is incumbent upon an institution of higher learning to be certain that students not know only how to build a bridge, but also how to ask why the bridge is being built: is it being built to get people to places of business or entertainment, or is it being built to transport victims to concentration camps?

Perhaps only a Pollyanna would expect to awaken in students a new social responsibility. However, at least, students can be encouraged to appreciate that it is in their own self interest to recognize that they share a university, a city, a planet with people of different backgrounds and assumptions, some of whom lack many of the advantages with which many college students have been blessed.

At NJIT the effort is being made to remove the rose-colored glasses and grapple with difficult issues. In fact the Center for Technological Studies as well as a Science, Technology and Society program, which is an NJIT-Rutgers University enterprise, focuses on social dynamics. Acknowledging the obligations of an urban institution with a multicultural student body, the university is moving ahead aggressively, developing programs to meet the challenges of the nineties.

ENDNOTES

A new study by the National Institute Against Prejudice & Violence, a Baltimore-based research group, documents racial incidents at 250 colleges that occurred since Fall 1986. Universities wrestling with these problems include prestigious institutions such as the University of Michigan, the University of Wisconsin and Stanford University. See **"Lessons from Bigotry 101"** (pp.48-49) and **"Black and Blue, Class of '89"** (pp.50-51), Newsweek: September 25, 1989.

The term, "*naivete*" is being used here in the same way that Graham Greene likens a naif to a leper that has lost his bell. The point is these naive students are not evil; rather they are ill-informed and filled with misconceptions, a condition that can be dangerous if not corrected by education.

EDUCATING WOMEN FOR EMPOWERMENT IN A TECHNOLOGICAL WORLD

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As part of a panel addressing various aspects of the education of girls and young women in science and technology, this paper deals with the early education of girls in science and technology.

When sizable numbers of girls and young women begin opting out of elective sequences in science education, the common cry is, "What is wrong with the girls?" I believe that we are asking the wrong question. The issue that needs addressing is framed by the question, "What's wrong with the science education?" I am always troubled when large numbers of girls and young women lose interest in an entire field of study. It requires that we place the science education enterprise under the proverbial microscope and investigate the science teaching and learning environment.

If we are to improve science education for girls and young women, we need to start early. Researchers have documented the ways in which boys and girls are treated differently in elementary school classrooms (Sadker & Sadker, 1982, Greenberg, 1985) and these differences are more pronounced in the elementary science experience.

I will discuss some of the characteristics of the differential science learning environments in the elementary school. Let's begin with inviting students (2nd grade and higher) to draw a picture of a scientist. Their scientists are predominantly male with facial hair, eyeglasses, a white lab coat and uncombed hair (Fort & Varney, 1989). Girls as well as boys have bought the dominant cultural stereotype of the weird scientist. Elementary school environments need to promote gender equity and to begin with providing role models for all the students. Inviting a local chapter member from the Association for Women in Science is a first step towards letting the students know that women are shaping their futures with scientific work. Researching foremothers in science reveals the fact that women have always done science and among them are a number of world class scientists. Test yourself...do you know who these women are: Maria Mitchell...Ellen Swallow Richards...Annie Jump Cannon...Antonia Maury...Dorothy Hodgkin, Gerty Cori?

At every level, cultural norms inhibit the identification of girls with science. Various strategies of encouragement need to be employed. Both girls and boys must be actively engaged in doing science. Frequently, science teachers tend to DO the laboratory exercise for the girls while encouraging the boys to figure it out on their own. Far from helping the girls, the message given by the teacher is, "you are not able." Both girls and boys need to be involved in conversations about science. In the classroom teachers need to listen for the soft, small voices of some female students in the presence of the more aggressive, frequently more vocal male voices.

Both girls and boys need to be encouraged to image themselves as future scientists with the ability to shape research agendas to their own goals. Students, therefore, need to hear scientists referred to as "he" or "she". The use of the generic "he" to represent both genders is exclusionary and young children do not receive the inference that "he" means "he" or "she". Science is seen as a male province where assumed female squeamishness and lack of mechanical aptitude has no place.

The assumed squeamishness of girls in the science laboratory is an example of cultural stereotyping that prevents girls from fulfilling their potential in science. Many women confess to being delighted to handle messy experiences in science, but for appearances' sake, pretend to be squeamish. A most interesting phenomenon is that frequently the women of our planet take care of the messes on a daily basis. Therefore, while girls are not expected to handle the science messes efficiently, the women they grow into are in charge of messes daily.

The girlhood stereotyoes do not allow for girls' "getting messy", yet it is the WOMEN who do the real "messing about" as they maintain the daily fabric of life. They are messing about with diapers, chickens, turkeys, toilets and the business of birth.! What's for dinner? Women are engaged in nightly dissections in the preparation of the evening meal and yet I am reminde of the story told to me by a student: "I did not mind dissecting the frog in seventh grade though that was not how I reacted...I screamed so that the boys would notice I was acting like a girl".

What is most important for teachers to recognize is that the reasons that girls avoid science are found in the ways in which they are socialized and the expectations that teachers and the community have for their achievement and their career plans. Since the reasons that girls do not continue in science have to do with social pressures, educators need to make their science classrooms more "girl friendly" to compensate for the lack of role models and encouragement provided to girls for careers in science and technology.

Here are some guidelines to help you rate your classroom teaching practices in math and science:

1. Do you call on boys more frequently than girls?

2. Who are your four top students in science? What is their gender?

3. Is your classroom sex segregated in seating, work groups and informal interactions?

4. Do you use gender-free language and occupational titles?

5. Do you make connections between your science teaching and the outside world?

6. Do you invite women in science and technology to speak to your students?

7. Do you do the science lab activity for the girls, while encouraging the boys to do it on their own?

8. Do you have the same expectations for the success of your girls in science as you hold for the boys?

9. Do you let the girls know that they are capable and competent in math and science?

10. Do you praise the girls for their appearance while praising the boys for theie accomplishments?

The above questions are designed to begin a process of soul searching that may enable you to change classroom behaviors that may inadvertently turn girls off to science. Teachers need to ask themselves "What factors influence the interest and achievement of girls and young women in science?" In addition to important methodological considerations, researchers find that girls tend to becomne more involved in the stduy of science and technology when its connection to real wrold issues and concerns are emphasized. This is a vital agenda for the transformation of traditional science education to Science-Technology-Society (STS) education (Koch, 1988). The integration of scientific concepts with technolgy and their impact on society is a way to teach science in its social context. When science education transforms its agenda to include STS education, we will not have to worry about attracting the girls; they will be drawn to its commitment.

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MEETING THE CHALLENGE OF SCIENCE, TECHNOLOGY, AND SOCIETY EDUCATION FOR LANGUAGE MINORITY POPULATIONS IN THE U.S.A.

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As people around the world awaken to the urgency of taking proactive steps to counteract environmental devastations and other threats to our common survival on the planet, the U.S., as the world´s largest consumer of energy and natural resources, must share in the responsibility of ensuring humanity´s future.

The ability of our Earth to continue to support life is in question. The purpose of this presentation is to provide a rationale for the development of bilingual programs which offer science, technology, and society(STS) Education as its unifying focus.

Fostering International Cooperation

The decade 1990 to the year 2000 has been designated by the UNESCO/United Nations Environmental Program International Congress on Environmental Education and Training as a World Decade for Environmental Education (UNEP News,1987). "That solving environmental problems brings nations together rather than dividing them is slowly gaining credence in international circles. But that environmental education amounts to education for peace is a new concept" (p.4).

STS issues are global and the threat to our planet does not distinguish humankind´s political boundaries between nations. Peace and justice cannot be served when there is a dominant language or ethnic group imposing its beliefs and values on others, whether domestically or internationally. This author believes that in the interest of fostering international cooperation to solve issues related to STS, one viable solution should lay in the implementation of bilingual programs which offer to all students who wish to participate:

* an opportunity for English-speaking and non-English-speaking students to learn each others´ languages and to learn about each others´ cultures in a climate of mutual respect and understanding;

* an action-oriented STS curriculum designed to bring an awareness of the issues to all students through hands-on activities, cooperative learning, and subject matter presented in more than one language. Through the vehicle of a well-defined STS curriculum, students will be able to develop their bilingual, literacy, numeracy, interpersonal, intercultural, and scientific literacy skills.

* community and parental participation to enhance the intercultural and multilingual aspects of the curriculum. Students and their families will be encouraged to share information learned at school and develop outreach strategies to their respective language communities.

While the above suggestion may seem to be revolutionary to some, the author believes that the issues merit visionary and innovative approaches to the way children in America are educated and socialized. One thing we know for certain is that the American educational system is failing; the time for restructuring and bold action is upon us (Shanker,1990).

A Decade of Educational Reform

The decade of the 80's ushered in a national agenda for educational reform. Since the debut of the Nation at Risk in 1983, commissions, task forces, and councils have been convened on every topic imaginable to study, analyze, synthesize, and recommend ways in which education in America could be revitalized and improved.

Specifically concerning science education, numerous national reports and recommendations have been published to assist educators, policy-makers, and others to enhance the sciences and increase access and effectiveness for all segments of society (American Association for the Advancement of Science,1989; Social Science Education Consortium,1987; The National Science Board Commission on Precollege Education in Mathematics, Science, and Technology, 1982).

Without exception, these national reports point to the need for improving access and equity for minority groups. Often cited in the educational literature are demographic predictions of rising numbers of minority populations (Cuevas,1984; McBay,1989; Oxford et al.,1981; Waggoner, 1984;). The United States has an enormous, but underutilized human resource potential of a growing population of language minority people, both native to this nation as well as immigrants and refugees.

During the 1970's and 1980's, the U.S. experienced its largest immigration wave. It is estimated that the foreign born population in the U.S. currently may exceed 15 million (Haney,1987). Although people come to the U.S. from every corner of the world, the majority of newcomers are from Mexico, Asia, Central and South America, and the Caribbean (National Council of Advocates for Students, 1988). If we consider demographic predictions based upon the average age and fertility rates of this population, future numbers will do doubt reach even higher.

Cultural and Linguistic Diversity in the U.S.

Changing U.S. demographics have motivated top level policy makers to face the inevitable: America cannot survive exclusively on the human resources of middle class white America. One conjectures that either our educational system becomes more hospitable and effective with minority students, or it will ultimately become dysfunctional and face its own demise -- bringing the nation down with it. In short, America has a vital need to encourage minority participation in all facets of national life.

In order to provide quality educational experiences for minority populations in the U.S., educators, administrators, and policy writers must do a better job of differentiating student characteristics and meeting educational, social, and psychological needs. Cultural diversity exists within all ethnic groups. To ensure effective and appropriate educational services for Asians, American Indians, African-Americans, Latinos and others, teachers must know something about their "clients" (Tsang,1984; Bradley, 1984). However, more often than not, American educators do not have a personal knowledge about their students home lives, cultures, languages or special needs. A case in point is the 1989 Phi Delta Kappa study of students at-risk; when data on 22,018 students in 87 communities throughout the nation was studied and analyzed by Frymier (1989) and his PDK team of researchers, an important and critical issue emerged: teachers lacked information about their students. He states: " If nonacademic factors contribute to at-riskness (and they do), teachers and counselors who do not have access to such information or who do not take the time to seek it will never know some of the most important factors affecting student learning" (p. 31).

This concept is not new. Bilingual educators have been saying this for years. Cardenas and Cardenas (1977,p.1) state: " An instructional program developed for a white, Anglo Saxon, English-speaking middle class school population cannot be and is not adequate for a non-white, non-Anglo Saxon, non-English speaking, or non- middle class population."

Without adequate dissemination about the populations cultures, cognitive and learning styles, and other factors, how can we expect teachers and administrators to address the realities of a diverse student body? Without a commitment to training and hiring bilingual teachers with multicultural skills we cannot expect to meet the educational needs of our multilingual populations.

It is ironic that while the business sector knows that it could never survive without having intimate knowledge about its market and the needs and wants of a given target population, the educational community is still functioning as if its clientele were culturally and linguistically homogeneous.

The Current Status of Bilingual Education

The National Coalition of Advocates for Students (1988) conducted a farreaching two-year research project to document educational experiences of immigrant children in U.S. public schools. The results of this study brought into public consciousness once again what proponents of bilingual education have been experiencing at every turn:

o Large numbers of Limited-English-Proficient (LEP) students are in poorly implemented and underfunded bilingual programs, if in a program at all.

o Recent school reforms have made our educational system even less flexible and less responsive to diversity.

o Teacher training is still lagging behind in developing culturally sensitive and skilled teachers capable of providing equal educational opportunities for LEP students.

o Intergroup conflict, racial tensions, and negative stereotypes and attitudes continue to detract from a school climate conducive to the promotion of dignity, harmony, and cohesiveness.

There are a range of programs for non-English and limited-English-speaking students in American schools. However, the great majority of them do not attempt to develop native language skills nor do they promote integration and cultural sharing among English-speaking students and speakers of other languages.

Despite the fact that in the U.S. there exists a proven need for intercultural sharing, foreign-language education, and cultural sensitivity training, programs geared toward populations who could enhance and enrich the entire school curriculum with their expertise and life experiences have not been promoted.

Transitional bilingual education programs have as their mission to take a potentially bilingual and biliterate student and make him over into an English-speaker only. The effects of this type of program on cognition, self-esteem, global awareness, intercultural sharing, and appreciation of one's cultural heritage have not been positive.

Bilingual education research and programs have demonstrated the benefits of bilingualism, suggested effective pedagogical practices, and have contributed to American education (De Avila et al., 1987; Hakuta & Gould,1987; Medrano,1988; Pagni,1989; Secada & Carey,1989), and yet, the trend to thwart the use and maintenance of the native language continues. Bilingual education has been conceptualized by many administrators and non bilingual educators as merely a bridge or a crutch to English. Programs nationwide have been underfunded and understaffed for the most part, and the teaching of English has been emphasized at the expense of academic subjects like mathematics, science, and social studies (Ochoa & Caballero-Allen,1988).

Regardless of what research suggests about the benefits of native language instruction (Cummins, 1981; Cardenas, 1986; Willig, 1985), if those in decision-making positions have a mind-set not to provide adequate resources for public bilingual education programs, the issue of which language to use for instruction becomes moot. For the past twenty-two years bilingual educators have led the way in providing a viable educational alternative for

LEP students, and much progress has been made in understanding the value and importance of the native language in relation to cognition, intellectual development, and academic achievement. Yet, it appears that no amount of logic or appeals to reason are adequate enough to quell detractors from undermining these efforts. Such quests as making English the official language of the United States or attempting to repeal state bilingual education policies as U.S. English tried to do in New York State through a deceptive media campaign (Garcia,1989) have become an everpresent barrier to access and equity.

Furthermore, during the Reagan years, when "choice" became a buzz word, states began to permit the placement of LEP students into English as a second language programs instead of providing them with much needed bilingual education programs (Spener, 1988). The results have not been positive. Many of these so-called ESL programs are pull-out programs offering only one half hour per day of instruction in English; the rest of the day the students attend regular classes languishing in the shadows of their English-proficient classmates with teachers who know nothing of their culture, language, or educational needs (Gonzalez, 1980; Santos, 1986;1990).

A Global Perspective of Language Minority Education

There is a growing body of international literature concerning the education of ethnolinguistic minorities in many nations around the world such as former European colonies, Great Britain, Australia, South Africa, Mozambique and many others (Berry,1985; Bishop,1988; Brodie,1989; Dawe,1983; Gerdes, 1988; Presmeg,1988).

This body of literature is very useful in that the issues raised mirror those affecting ethnolinguistic populations in the United States. The author discovered that much of the description of the status of instruction in bilingual education in nations which have been colonized or have practiced colonization closely parallels U.S. studies documenting the struggle for access and equity.

This writer believes that ethnolinguistic minorities in the U.S. are commonly pressured into discarding their linguistic and cultural conceptual frameworks upon moving through the Anglo-centric U.S. educational system. This system rewards Anglo conformity and promotes the maintenance of a status quo in which success for minorities is determined by their degree of assimilation and willingness to play a subordinate role, even in the face of injustice and oppression. A similar picture emerges in other countries worldwide as immigrants, refugees, indigenous peoples, and cultural and linguistic minorities not of the dominant ruling class are relegated to secondary status.

Bishop (1988,p.179) states that " In some countries like the U.K., pressure has mounted to reflect in the school curriculum the multi-cultural nature of their societies, and there has been widespread recognition of the need to re-evaluate the total school experience in the face of the educational failure of many children from ethnic minority communities".

We must not fear to look for answers in our political and economic systems ,in educational opportunities offered to students, in the appropriateness of the delivery system, in the ability of teachers to motivate and unlock students' potentials, in the resources allocated to special programs for language minorities, and toward other factors external to the "victim."

Brodie (1989), in an article stemming from her experiences as a teacher for Black South Africans questions the desirability of teaching academic subjects in a non-native language. She gives evidence that learning in a foreign language can result in "serious cognitive difficulties" (p.40) and supports the theoretical frameworks of Cummins, De Avila, Krashen, and others whose pioneering research efforts have made significant contributions to the field. The following quote from her work will enable American educators to perceive the parallels.

> South African society is made up of many different language groups...English and Afrikaans speakers are descendants of European colonists who arrived between 1650 and 1900... The majority of people, black South Africans, speak one or more of a number of African languages...and in South Africa they do not have the same status that is accorded to English and Afrikaans. Education for black students is usually in the vernacular in the first years of primary school and in English in later primary and secondary schools... Thus the overall aim is for the student to make a transition from her first language to an official language...(p.41).

Conclusion

The survival of humanity into the next centuries will depend upon how well people from around the globe can unite to identify and tackle environmental and other threats to our collective existence. Values such as cross cultural cooperation based upon respect for human dignity and self-determination, irrespective of national jealousies or political boundaries, must be fostered if we are to ensure the continuance of life on our planet.

No one has disagreed with the importance of knowing English, but the promotion of monolingualism and ethnocentricity in today's interdependent, and possibly dying planet, is not only dangerous, but goes against the democratic principles upon which our nation was founded.

History will judge us by how well we teach our young to value life, protect our dwindling natural resources, and interact with each other in ways that foster harmony and cooperation.

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SCIENCE STAR AND HEALTH EPIC - SUCCESSFUL SUMMER BRIDGE PROGRAMS FOR MINORITY HIGH SCHOOL STUDENTS

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Historically, members of minority groups have been underrepresented in the sciences and in the health professions. Since Kean College of New Jersey is a recognized leader among colleges for offering undergraduate programs in these areas, we felt an obligation to address this problem. One of our approaches has been the building of Bridge Programs between Kean College and area high schools.

In Science STAR and Health EPIC, we identify and recruit minority students in their junior year of high school, blacks and hispanics in particular, who express an interest in pursuing careers in the sciences and in the health professions. These students are then allowed to explore a broad range of career options. The program works to increase the motivation of these students, and to help improve those skills which will increase their potential for success.

The Bridge Program has been offered for the past four years. For the first two years, the program consisted of bringing high school students on campus twice a week during the academic year, and offering them courses at the college freshman level. The students were awarded college credit for successful completion of each course. The program was only partially successful in this form, suffering from a high attrition rate among the students.

In 1988, the program was restructured into its present form, a five week summer program. Both Science STAR (to encourage interest in the sciences) and Health EPIC (to present the opportunities for health-related careers) are similarly structured. Like the rest of the State of New Jersey, Kean College is in session for four days a week (Monday to Thursday) during the summer.

The students are grouped together for Vocabulary Building (at the start of each day for three-quarters of an hour), separated into Health EPIC or Science STAR groups for the academic sequence (the remainder of the morning), join together with the instructors for an informal lunch, and then are grouped together for an hour and a half of Problem Solving.

The recruitment process for our program begins with a luncheon at Kean College for high school principals, science department heads and guidance counselors at which we present our program. In our first year, we dealt exclusively with guidance counselors and were less successful in getting students. The meeting at Kean is followed up by visits to the high schools to meet and talk with students. Interested students complete an application form. Students are selected on the basis of letters of recommendations from counselors or teacher.

Students are grouped with participants from high schools other than their own as much as possible. They tend to stay with their new friends even at lunch. Faculty for the groups in the Academic Sequence and for Problem Solving consist of a Kean College faculty member paired with a teacher from an area high school. This pairing has been most successful, with both partners benefiting from the knowledge and experience of the other.

This year, recognizing that the students we seek to recruit for this program would otherwise be working to earn needed money, we paid the students a stipend of $300 for successful completion of the program. The stipend was paid only if the student's attendance was satisfactory - the student must attend 90% of the sessions. The students were informed in the second week that two latenesses to any activity would count as an absence, solving a problem that we had, especially in our afternoon activity on nice summer days. The habit of coming on time to class is particularly important for success in college, and tying the stipend to punctual arrival in class should help the students develop an important skill for college.

Bus transportation to the program was provided by most of the high schools from which our students were recruited.

The program was evaluated by students and staff at the end of the summer, and was highly praised. On a scale of 10, the average rating was a 9-plus. The students have been entered in a data base, and follow-up evaluations are planned for this spring, and in the next few years.

The programs in the academic sequence are tailored to meet the aims of the two groups. Health EPIC is designed to help students explore the health professions - especially areas they may know little about such as occupational therapy, physical therapy, medical technology, nursing and medical record administration. Students who are interested in becoming physicians participate in the science program. Science STAR explores what a scientist does and the interactions among the science disciplines. Few students really understand how a scientist goes about solving a particular problem.

Project Science STAR is a hands-on experimental approach to science, showing the interactions between disciplines (biology, chemistry, earth science and mathematics) as the students work on a project. The topic of their project for the last two years has been: "The local government proposes building a trash incinerator in your local community. How would you, as a scientist, gather information to support or reject the proposal?"

The students meet with each discipline one morning a week. They are directed toward designing experiments and gathering data. The experiments are novel in the sense they are not "exercises" with predictable outcomes. They demonstrate that not all experiments yield positive data, and allow the students to re-think a hypothesis or experimental design.

The mathematics component is used for analysis of actual data, using computers. Students are given the theory of statistical approach to analyzing data, with exercises to demonstrate the approach. By the time they are familiar with the theory and the computer package, they have data from their experiments in the other disciplines to analyze.

The last week of the academic component is spent in the library collecting information from the literature for use in a debate, held on the last day, as to whether or not an incinerator should be constructed. The students are shown how to use the computerized literature retrieval system and how to search for primary and secondary literature sources. They also learn how to organize a presentation.

In Health EPIC, the students learn about a different health profession each week, in a highly organized weekly schedule. A presentation is made by a health professional, giving the students information on what the profession is about, what he/she does, what education is necessary, and the practical information about what the job pays and what the chances for advancement are. The presentation is followed by a tour of a health facility that illustrates first hand that particular profession.

The students also have a biology laboratory experience, as biology is a core discipline for all of the health professions. As in Science STAR, this is a hands-on experimental approach, not talk-to or look-and-see. The students also work on the computer, learning word processing, and evaluating games (e.g. for suitability in rehabilitating an individual with damaged hands or lack of muscle control.)

A very important component of our program in both Science Star and Health Epic is the building of the skills that will enable our students to pursue the careers that they are learning about. The skills are important to gain admission to the programs of study that lead to these careers, and for success in the studies and the careers that follow.

Students from both programs join together to study Vocabulary and to study Problem Solving. The Vocabulary sessions are three quarters of an hour as the first activity of each morning. The students work from the book "Vocabulary for the College-Bound Student" by Harold Levine, Amsco School Publications, Inc., New York. Late in the program, the students have an opportunity to compete with each other using the vocabulary they have learned in a "Vocabulary College Bowl." They compete eagerly, and the amount of new knowledge exhibited by the students in this competition is very impressive.

The students from the two programs are also mixed together for Problem Solving, which runs for one and a half hours after lunch on Monday, Tuesday and Thursday, with Wednesday being reserved for special activities such as the "Vocabulary College Bowl." The students work, most of the time in pairs, using "Problem Solving and Comprehension" by Whimbey and Lockhead, 4th Edition, Lawrence Erlbaum Associates, Hillsdale, NJ.

In the pairs problem solving approach, one student is the active problem solver who must explain his/her reasoning to the other student, the listener. The process of being forced to explain the reasoning in each step forces the solver to be conscious of what he is doing, and helps avoid careless assumptions and skipping of steps. For the next problem, the students switch roles.

The problems the students solve from the book include the traditional (but essential) word problems - the only type of problems that they should encounter in college science courses - and some other types of problems that improve reasoning skills and test taking ability, such as analogies. The instructors try to show that different approaches can work to solve a problem, and that there is no one magic formula that a student can and must memorize. On demonstration problems, after a student volunteer has presented a solution, the class will be asked if anyone tried a different method, and a student, or one of the instructors will show an alternate solution.

The problem solving instructors also bring in extra activities. Some instructors bring in brain teasers and famous math problems. Some of the students respond by bringing in problems of their own to stump the instructors.

Late in the program, some instructors let their students try a sample SAT exam. The students are surprised and pleased with how much of the material they have learned during the summer helps them to answer the questions on the SAT.

Many of the instructors spend time at the end of the sessions in nearby computer labs, with the students "playing games." In order to play the games, the students are taught how to turn on the computer, load DOS, switch disk drives and find the executable file. The games are chosen to have some problem-solving component. Examples are "Jeopardy" which encourages students to use available clues (i.e. the category) to come up with the appropriate answer, and requires accurate spelling in the response, and "Tetris" which helps improve the player's spatial relations.

The problem solving book includes a pretest and a posttest. While I believe that the posttest has several flawed questions, and is not valid for serious statistical studies, we do administer it to our students. Many of the students are delighted with how much they have improved over the five weeks of the program; the instructors are delighted too.

We think that Science STAR and Health EPIC are excellent programs. Both our students and our staff are enthusiastic, and we believe that we are accomplishing our goal, introducing minority high school students to health and science careers, and helping to prepare them for successful entry into a college program, and their future careers.

GIRLS IN MATHEMATICS AND SCIENCE: AN ENDANGERED SPECIES?

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Introduction

The National Council of Teachers of Mathematics (NCTM) has produced a document entitled Curriculum and Evaluation Standards with the purpose of setting the direction of school mathematics in the current decade. Educators have begun the process of evaluating the role of the Standards in their own school systems. In the Introduction of this document, the NCTM proposes a set of new societal goals to be met by the schools. These listed goals are (1) to produce mathematically literate workers, (2) to stress lifelong learning, (3) to provide opportunity for all, and (4) to generate an informed electorate. In the section, "Opportunity for All," the NCTM states:

> Current statistics indicate that those who study advanced mathematics are most often white males. Women and most minorities study less mathematics and are seriously underrepresented in careers using science and technology. Creating a just society in which women and various ethnic groups enjoy equal opportunities and equitable treatment is no longer an issue. Mathematics has become a crucial filter for employment and full participation in our society. We cannot afford to have the majority of our population mathematically illiterate. Equity has become an economic necessity.

In the July 1989 issue of the Journal for Research in Mathematics Education, the Research Advisory Committee of NCTM contends, "Very few programs have implemented instructional practices that, according to theoretical and research-based models, are likely to assist young women in becoming autonomous learners of mathematics." To summarize, much research and many equity projects have been done but not implemented in the classroom. Teachers have the ability to change classroom practices by testing various research hypotheses. Researchers must focus on "new models of learning, new ideas about curricula, new instructional practices, and new teacher-preparation procedures." Some comments of the NCTM Research Advisory Council are:

(1) "Funding agencies must support research efforts addressing the mathematics learning of the underserved and underrepresented."

(2) "...we need research that addresses how to change the in-classroom teaching and learning environment."

(3) "Coordination of the efforts of the well-meaning groups studying this issue is seriously needed....At the moment it is very difficult to know 'what we know' about the issue at hand."

(4) "...the more we understand about teaching students who have not entered into the mainstream of mathematics, the closer we will be toward understanding how to teach all students."

In the March 1989 issue of Educational Leadership, a report that targetted teachers and administrators in the National Education Association, the National Association of Elementary School Principals, and the National Association of Secondary School Principals indicated that a majority (57%) of respondents felt that little has been done to increase the academic achievement of girls by the reform movement on educational equity. In this article, Myra Sadker, David Sadker, and Sharon Steindam note: "Girls are the only group who enter school scoring ahead and 12 years later leave school scoring behind. The decline of academic achievement experienced by half our population remains an invisible issue." A lack of female presence in mathematics and science careers could prove devastating to our future as a technological nation.

In conjunction with the above, consider the negative implications of recent radical feminist literature in supporting the view that mathematics and the sciences are not feminine. In "Feminist Critiques of Science", Allyn Jackson states:"...some recent radical feminist literature...may have the effect of discouraging women from entering mathematics and science. In addition, because some of this literature perpetuates stereotypes and misconceptions about mathematics and science, it is related to the larger issue of public perceptions about mathematics and science..." Media publicize these results and perpetuate the notion that women cannot be scientists since science is a masculine activity.

Relevant Statistical Studies

Demographic studies indicate that the United States workforce will change by the year 2000. Women will account for 47% of the workforce, an increase of 3% since 1986. Thus, women will be approaching half of the workforce in the next ten years. In contrast, only one generation in the past, women were approximately 30% of the work force.

Are women half of the available, trained workforce in the fields of mathematics, sciences, engineering, and computer science? Consider some relevant current statistical reports.

In the 1989 Annual AMS (American Mathematical Society)-MAA (Mathematical Association of America) Survey, Edward A. Connors reported that "411 U.S. citizens received doctorates in the mathematical sciences. This is only 46% of the total awarded by U.S. institutions, however." In addition, Dr. Connors notes that "24% of the U.S. citizen doctorates were awarded to women. This is the largest percentage ever and a significant increase over the 20 to 21% awarded in the last six years." There has been a definite increase in female U.S. doctorates in the mathematical sciences from only 9% in 1973-1974 to 24% in 1988-1989 but Dr. Connors points out that "...only 16% of the new doctorate hires in the U.S. doctorate-granting departments were women." Note that women are far from 50% of the mathematical pool available.

In An Exploration of the Nature and Quality of Undergraduate Education in Science, Mathematics and Engineering: A Report of the National Advisory Group of Sigma Xi, the Scientific Research Society, some findings from the UCLA Cooperative Institutional Research Program (CIRP) survey of the American Council on Education were enumerated as follows:

. Freshman interest in fundamental undergraduate science majors has dropped dramatically - by almost half - over the past 23 years.

. Freshman interest in technology careers has experienced a dramatic decline in just the past six years. Between 1982 and 1988, the proportion of freshmen planning to pursue careers as engineers fell by almost one-quarter; the proportion of freshman[sic] planning to pursue careers as computer professionals has plummeted, falling by nearly three-fourths in just six years.

. Every year tens of thousand of academically-able students enter college planning to pursue science majors. Yet more than half of these students change their intended major for other, non-science fields. Moreover, the high 'defection' rates for aspiring science majors are not offset by recruits from other (non-science) fields.

. The disciplinary-training of secondary school science teachers has declined dramatically over the past two decades. Today very few aspiring science and math majors plan to pursue careers as high school teachers.

The CIRP data indicate that, although women have been encouraged to pursue science careers in the past two decades, their interest in science careers actually dropped from 8.8% in 1966 to 5.1% in 1988. There has been a definite loss in women preparing to be teachers in the discipline as they pursue other science careers and options. The present situation is not encouraging. Consider the following paragraph. Ponder its message to the future.

- "Teaching is a situation where the loss of the 'captive population' of women has had dire consequences for the sciences... As women's aspirations and opportunities have increased over the past two decades we have lost a key resource in the pool of potential science instructors, as well as a key group of role models for women who might be interested in both the sciences and in secondary school teaching careers.

The lack of interest in science and technology has serious repercussions to the future challenges of this decade and the next century. How will the United States fare as an economic power with a dearth of scientists, mathematicians, engineers, and technologists? Will the United States slip even further down the scale measuring economic supremacy?

In the Report on the National Science Foundation Disciplinary Workshops on Undergraduate Education, it is noted that, "...the problem of shortages of mathematicians, scientists and engineers can be solved if underrepresented groups participate in these fields in proportion to their presence in the population." Some recommendations were to identify and nurture such students, to have role models available, to make an effort towards retention, to recruit, and to give financial support to women, minorities and disabled.

The January 1990 issue of Computing Research News describes the results of the 1988-1989 Taulbee Survey Report on the production and employment of PhDs and faculty in computer science and computer engineering. Of 625 PhDs awarded in Computer Science, 87 (14%) were women; of 182 PhDs awarded in Computer Engineering, 20 (11%) were women. Of the total 807 PhDs, 107 (13%) were women. The report indicates that far too few women are in the field and the retention of women faculty is "abysmal."

The Cooper Union 1989 National Survey of Undergraduate Women Engineering Students delineates the following conclusions:

Only 6% indicated a strong interest to pursue an academic engineering profession. This continues to be problematic since most female engineers have few female role models, but expressed a strong wish for female mentors.

The survey indicates a high level of supportiveness to study engineering from family members and friends.

However, strong support appears deficient from guidance counselors and high school teachers.

Many express concerns about gender issues in the workplace.

The Cooper Union 1989 National Survey of Women Engineers enumerated the following conclusions:

> The survey findings indicate a high level of satisfaction among working women who pursue engineering careers.
>
> However, gender issues are still prevalent in the work place, with nearly two-thirds believing that they have to work harder than male engineers doing comparable jobs.
>
> The survey indicates insufficient support systems for young women who express an interest in pursuing engineering careers.
>
> More than half of the women engineers had family members who were or are engineers.
>
> However, respondents indicate that support was lacking from high school math and science teachers, and, more apparently, from high school guidance counselors.
>
> ...There is a need for more female role models in academia. Nearly three fourths say networking with other women in the workplace is important.

From all these current statistical surveys, it is clear that women do not represent half the workforce in careers involving mathematics, science, and technology. There very definitely is a math/science crisis in the United States. What are the implications of the failure to encourage girls in mathematics and science? The U.S. will suffer internationally if this pool of workers is lost and not nurtured. What are the causes of the lack of women in mathematics, science, and technology? What are some possible remedies?

Some Causes and Remedies

What does research have to offer to help alleviate the current perplexing problem of girls as an endangered species in mathematics, science, and technology? There are a plethora of studies available. It is not possible to read every study and to examine exactly what each study has actually done. Dramatic conclusions become publicized and are treated as basic assumptions and theorems and not disputed. As Allyn Jackson notes in "Feminist Critiques of Science", there are many flaws in studies that claim the biological superiority of males in mathematics and science. There are flawed biological theories about women and hormones. Studies that conclude that men have more innate ability in mathematics have been criticized and "debunked;" yet they are still cited in the literature. As with all statistical studies, the "proof of the pudding" is not in the sweeping conclusions but in what was actually done in the study.

Many texts and articles contain extensive bibliographies of applicable research. Many sex equity centers have published excellent resource manuals. What are some possible causes of the lack of females in mathematics and science careers? What are some suggested remedies to increase women's interest and participation in math/science activities and careers?

Some causes cited in the literature are gender differences in the following:

1. Spatial ability.
2. Verbal ability.
3. Quantitative ability.
4. Science knowledge and scientific reasoning.
5. Aggression.
6. Confidence.
7. Interest in math and science.

8. Social influence.
9. Altruism and nurturing.
10. Physical ability.

In the November 1989 issue of Educational Researcher, Marcia C. Linn and Janet S. Hyde explore in depth each of the above gender difference. They conclude:

a. gender differences on cognitive and psychosocial tasks are small and declining,
b. gender differences are not general but specific to cultural and situational contexts,
c. gender differences in cognitive processes often reflect gender differences in course enrollment and training, and
d. gender differences in height, physical strength, career access, and earning power are much larger and more stable than gender differences on cognitive and psychosocial tasks.

They propose that"...small gender differences in cognitive and psychosocial domains be deemphasized and instead that learning and earning environments be redesigned to promote gender equity." Some suggestions given are to use teaching techniques that provide "feedback on the use of problem-solving strategies rather than memorized algorithms," that "encourage expression of ideas from all students, not just the most confident or aggressive," and that "reward both the individual achievement and the cooperative behavior necessary in scientific investigation."

Some suggested remedies are the following:

1. Use of role models and mentors.
2. Activities to teach spatial abilities.
3. Use of non-sexist language.
4. Cooperative learning activities.
5. Care in handling intrapersonal classroom relations.
6. Encouragement of risk-taking.

Teachers have tremendous power to shape and mold their students. They influence their students every day. Reflect on the following quote from "Gender Equity and Educational Reform,"

> Girls and minorities are short-changed in the critical currency of classroom interaction. Teachers from grade school to graduate school ask males more questions, give them more precise feedback, criticize them more, and give them more time to respond. Whether the attention is positive, negative, or neutral, the golden rule of the classroom is that boys get more.

Ponder the following questions:

1. How can teachers help girls get noticed in mathematics and science classrooms?
2. Where should research be aimed to find viable solutions to the math/science crisis?
3. What can teachers do now to reverse this disturbing drain of half of our best and most promising students?
4. How important are teachers' attitudes in encouraging girls in mathematics and science classrooms?
5. Do non-threatening cooperative learning small group teaching techniques help girls?
6. How can teachers increase the self-confidence of girls in the classroom environment?
7. How can teachers encourage girls to be risk-takers?
8. What activities will encourage girls to stay in mathematics and science classes?

9. How can teachers help girls develop spatial skills?
10. How can teachers emphasize the utility and relevance of mathematics and science for all citizens?
11. What teaching techniques work best with girls?
12. Should teachers monitor the use of "target students" and the group dynamics of their classroom? How can they do so?
13. How can teachers influence guidance counselors and parents to encourage girls in mathematics and science?
14. What sublimal messages are sent to girls in textbooks, classroom materials, and the media?
15. How can teachers thwart the math/science crisis? How can success/failure and progress be evaluated?

The solutions to these problems reside in the classrooms across the nation. Therefore, ask the teachers!

Conclusion

In the February 1990 issue of Scientific American, Shirley M. Malcolm, head of the Directorate for Education and Human Resources Programs of the American Association for the Advancement of Science, echoes the sentiments of many in the essay entitled "Who will do science in the next century?" She responds to the question by stating, "That depends on who is included in the talent pool. The old rules do not work in the new reality. It's time for a different game plan that brings new players in off the bench."

Perhaps, it is time also for a new game plan in research. Teachers need to share their expertise with researchers and become researchers themselves. It is their classroom and they are experts in their own realm. More and more teachers need to get involved. The solutions to the math/science crisis are right there in the classrooms nationwide, and teachers are the key to bringing girls back from the endangered list. Girls can thrive in mathematics, science, and technology with nurturing from educators. Mentors and one on one relationships are the requisite lifelines to save the United States from the present math/science crisis. The teachers are the promise of a brighter future; they hold the math/science crisis "solutions manual" in their hands.

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A CASE FOR MULICULTURAL COMPUTING
CAN CASE SYSTEMS
GENERATE THE FLEXIBLE MEDIUM NECESSARY
FOR THE MULTICULTURAL ENVIRONMENT?

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ABSTRACT

Complaints about the ineffectiveness of computer assisted learning proliferate as declarative and script programs dominate the market and even form a glut in the computational environment. The multicultural environment of modern school systems only highlights the inadequacies and inflexibility of these script oriented programs. Innovations in the field add complexity to systems by making the tutors sensitive to the individual student's performance, but do not depart from the stereotype of the average student which is often greatly removed from the learning mode of the ethnic or linguistically distinct student population. In response to the current lack of a flexible tutor our investigation is oriented towards replacing the rigid student model with an adaptive learning model. Although computer assisted learning is evaluated in terms of twenty years of programs responding to the constraints of limited hardware, memory and software, the CASE system affords us the opportunity of finding an economically feasible solution while enhancing minority opportunities. The flexibility of the CASE system allows a shell to be configured with both the desirable trace and playback features as well as inference engines and neural nets. The ability to configure the CASE structure rapidly and test it, allows greater flexibility in choosing a tutor suited to that task. Thus, we are not faced with such an enormous investment that we cannot afford to create several versions of the desired program and reject them because of perceived inadequacies. Thus. it was discovered that Prolog tutors often fail to recognize the time sequence necessary for learning and also pose problems in the modern hypermedia. A neural net based upon microfeatures and a cognitive topology based upon rheme and theme distinctions can replace traditional nodes emulating cerebral hierarchical organization. This configuration is highly complex: requiring the interaction of three elements to compose the tutor: microfeatures in a recognition matrix linked to data bases and teaching strategies, an inference engine capable of comparing a model performance, a student performance and a metarule based on the Wechsler scale and an inference engine capable of completing partially correct ways of the world.

A TWENTY YEAR OLD BACKLOG

Complaints about the ineffectiveness of computer assisted learning proliferate as declarative and script programs dominate the market and even form a glut in the computational environment. As a result computer assisted learning is evaluated in terms of twenty years of programs responding to the constraints of limited hardware, memory and software. No clear solution to the problem has been forthcoming because of the nature of the medium and the participants involved. The easy medium, Basic and Pascal, favors linear programming.

However, learning is often non-learning and seldom homogeneous over any given group of students. Thus, script oriented software is only of limited value for student bodies with diverse learning styles. Moreover, educators have seldom studied formal logic and consequently find great difficulty in the logical problems involved in programming in C, Prolog and Lisp. Thus, the content of educational software is defined by the medium in such a way that the original goal, education, is obscured if not totally effaced.

BEYOND DESIRE: THE AUTHORING SYSTEM

By teaching, computing and technology at the doctoral level, I personally have experienced the limitations of educators who were both dedicated and eager to learn. Ultimately, beyond Basic, C, Pascal, Prolog and Turing, on a distant horizon were authoring languages which, for them, offered their only real sense of gain in graduate courses in educational computing. Therefore, let us assume that real gain in improving if not restructuring our twenty years of script oriented, linear software can only be effected by improving the authoring environment. The original inception of CASE responds exactly to the parameters of this educational problem: a large backlog of unsatisfactory software, a limited programming ability, a limited budget and an urgency dictating a restricted schedule for development. Current projects developing software and an interactive video medium for APPLE applications are set at fourteen million dollars for eight disks and the software interface. This means that the heavily subsidized product must be marketed at an initial cost of three thousand dollars per unit. The new software is excellent comprising tools for problem exploration, unlimited scenarios for the study of scientific ecology and interaction between the student and various experts. This heavily graphic and tool oriented educational medium served as a conceptual model in our design of a shell for knowledge based software already in existence.

THE CASE STRUCTURE

The current technology called CASE (Chedgey, 1987; D.B. Leblang, R. P. Chase, and G.D. McLean 1985) favors this development as never before simply because an environment (CASE, 1989; Garrett, Smith & Myrowitz, 1986) is available in which modules predominate. This reassessment of software development means that we can currently exploit the common ground defined as authoring shared by both database applications and educational goals (Cerri and Leoncini 1988). As has always been the case, software engineering is so expensive that educational concerns can only afford its own development in the institutional environment. As a result a shared domain with commercial applications tends to facilitate educational goals by providing modules which can be redefined in an educational environment.

The goal of this study is the definition of parameters for the educational exploitation of authoring modules in conceptual address systems (Stevens & Collins,1982; Sleeman, 1984) currently under development for use with databases. Can this environment be rendered as a friendly interface for educators facilitating their use of the graphics modeler, data structure designer, mathematics modeler, text processing tools, communications modeler, database designer and the tracebuilder, typically found in a CASE package? Although the critics of CASE decry its use of flow charts for programming, this was always one of the first tasks set for students in my class and in an earlier stage in programming. The use of the flow chart substitutes temporal sequencing for formal logic. Temporal sequencing is a part of the deep structure of the most elementary acts of learning as will be illustrated later in this paper in a discussion of the nature of thinking. An increasing interest in visual programming, and object-oriented design supporting windows, icons, menus, and pointing devices (Wasserman & Pircher, 1987) has given rise to CASE development tools and automated graphical workstations. Thus, the power of images over words, long evident to educators, has become an integral part of programming. The CASE tool combines this graphics based computing with idealized models of the world, paradigms. The attractiveness of the CASE development tool in the educational medium is the reduction in "telling", that is to say the use of manuals and programming languages by students with no background in formal logic. The CASE development tool "shows" by doing in the form of direct manipulation of "objects." No programming language is needed to "show" the user how to solve the computational problem. "Showing" functions on the level of cognition where ideas are translated into actions. There is no linguistic ambiguity in showing because it is our most primitive cognitive skill. Thus, the learning mode which is the targeted object of both the finished program and the programming medium.

THE CASE FOR A TUTOR

An educational environment needs all of the tools mentioned above and a tutor inference engine including pedagogical strategies and metarules. The essence of the educational system is a dialogue in which the student's performance is also an object (Goldberg, 1984) in the tutor inference engine, guiding the tutor in supplementing and correcting misconceptions. The differential between the expert knowledge separating the tutor and student performance models serves as a metric for the tutoring process. Such devices personalize the system allowing for learning modes, particularly, important for minority groups or visually oriented
learning modes.

The differential can also serve as a diagnostic metric revealing the effectiveness of the program itself by monitoring or tracing its success rate and preserving student models as future references for misconception patterns. Obviously, the complexity of this element demonstrates the need for a modular approach. The advantage in the CASE system is that each modification in the program will be integrated into all elements of the system. On the other hand is this really an advantage? In order for the tracebuilder to function, there must be a certain rigidity in its interpretation of sequencing. At times, the mind's need for a different sequencing is transgressed by the tracebuilder's desire for order. The essential factor in this case is the question of time as a value in the learning process. As a result the temporal sequencing of the mind must always be considered in designing a tutor.

The advent of hypermedia and CASE offer false hopes of resolving all of our educational problems. The two major problems are that users get lost in hypermedia and the user has difficultly gaining an overview of the material presented. Undoubtedly, the renown of North American students for their poor ability to analyze and synthesize raw data has spread throughout the Western world.

Although this problem is rooted in the American mass media, it is not desirable to replicate it in an educational media. Moreover, as hypermedia is frequently exploited as an authoring language the problems inherent in the medium are often carried over into the lessons. A failure to properly index keywords and concepts in a lesson turns the lesson into a labyrinth (Jones, 1987). Often the student who is uncertain of the ultimate goals of the lesson, will ask questions. Systems which always reply with a multitude of choices will not make these goals clear to the learner. As Raskin (1987) has pointed out regarding the use of hypermedia, the absence of a goal-oriented interface at the generic level often means that the system offers tools which cannot be made to perform the task at hand. This problem is largely resolved by segmenting the tools into a CASE system where specific goals and more or less user friendly interfaces are designed. The CASE not only provides greater cohesiveness in the lesson, but also the opportunity for providing a cohesive task-oriented authoring environment. Such was the inspiration for TEACHBACK and languages developed by the University of Oregon. If we accept the formulaic representation of prototyping proposed by Bose, Lewis, Hanloser and Yang (1988), " A prototype".

Q is a collection of user interface objects U, a set of actions A, and a mapping function F: Q=(U,A,F)" we can create vacuous prototypes as a stage in development which define all user interface objects, sequence the interface objects, giving rise to a mapping function, generate code, compile link and run the code. The vacuous prototype shows the interaction between the objects and functions and the functioning of menus, windows, black boxes and tools without performing the knowledge functions. This rapid prototyper allows you to experiment with various objects and tools in configuring your tutor.

PHILOSOPHIES OF EDUCATION AND THE TUTOR

Determining the metrics describing learning modes calls into question current philosophies of education. Without considering the earlier script oriented software, three options are available for the tutor's strategy: diagnostic, explanatory and supplemental (Cerri, 1987; Kempen, 1986). In each case the organization of the tutor/student dialogue is different and reflects a distinct philosophy of education. The earliest script software which might be restructured under a tutor served two purposes: drills and the simulation of experiments and real life knowledge not available in class. In the second case a communication model is exploited in which computer assisted learning is accepted as a cooperative dialogue similar to Gricean models for exchange. In the third case, the teaching model is restricted serving as a response to the active student model which is measured against misconceptions and supplemented with explanations. The first strategy is the most complex, perhaps, because it is derived directly from cognitive science suggesting that artificial intelligence become auto- referential in the program as a tool for measuring knowledge acquisition. In the diagnostic model the students localized performance is interpreted as a differential in the qualitative model derived from comparison with the tutor understood as expert. Such localized models are gradually transformed into a general strategy or metarule.

THE MULTICULTURAL DIMENSION

The educational system is in the midst of a cultural crisis encompassing issues from the ecological crisis to ethnicity. For the first time in our history we have the opportunity to ask whether the tools used in education benefit certain classes unequally. An overview of current software reveals the view of rationality that underlies modern technology, particularly with its emphasis in the manipulation of facts for decision making. On the other hand our belief in this rationality is diminished as a shrinking universe reveals ever greater degrees of chaos underlying this apparent order. In the educational system ethnic diversity has long been treated as a social disorder and even a latent chaos threatening Western logic. The goal of a re-examination of the tutor's logic points to a pregnant question underlying on current technological mindset: what constitutes chaos? The answer to this question might be most readily available by studying the learning modes of those judged by a rational system to be chaotic. In short, does the solution to the paradox of chaos lie merely on the other side of the cultural horizon--is chaos merely a plethora of rational systems interacting in a quantum parallelism (Penrose, 1989)?

NEURAL NETS AND EDUCATIONAL COMPLEXITY

We decided upon a format based on the Wechsler Intelligence Scale because this educational metric has standardized interpretations over a broad population and represented the type of metarule perceived at a neurological level, which was not domain specific but a measure of generalization. Thus, Wechsler tests as well as some Matrix and Block Recognition tests appear in each program as a pretest and as a type of relief from the domain specific area. In effect, the tests serve to regulate a scalar graph (Goldstein, 1982) measuring the differential between a performance model and the idealized model represented by Wechsler values and the current performance scheduling the tutor during the execution of the program. The strategy is based upon a diagnosis of the student's grasp of a total way of the world, an idealized paradigm representing both symbolic and representational knowledge. If the student has a partial way or incomplete knowledge of the symbolic structure or representation of the idealized paradigm the tutor supplements this knowledge by examining the microfeatures required and those present in the student's conceptual frame. Thus, the temporal data necessary to regulate synapse firing is considered to be analogous to the comparison of past and present states of knowledge as a measure of conditioned and unconditioned stimuli with the assumption that human success is based upon the maximum storage of conditioned stimuli.

INFERENCE ENGINES, MICROFEATURES AND NEURAL NETS

What is a microfeature in the neural net context? A Microfeature is a class of categorization which determines the configuration of conditioned synapses in the brain. This class is understood as a categorization of cerebral activity synonymous with Penrose's (1989) concept of a "quantum parallelism." In turn, the quantum parallelism constitutes the reduction of an infinite set to finite time in a neural net observed early in the development of connectionist processing by Frank Rosenblatt (1962). It is this process which the current author holds to be the physiological representation of thinking which is symbolically represented not by choices between falsity and veracity as is imposed upon the Prolog node-type tutor but upon a probabilistic theorem (Kuck, 1984) defining total and partial ways of the world. In a complementary inference engine the microfeatures are supplemented by a system which does not define falsity, thus, refusing simple refutation.

The microfeatures manipulated in order to complete the way of the world paradigm are of two large classes: concept features and representational features. The first category subsumes primitive classes, attributes, and disjunctions, whereas the second category defines predicates, domains and ranges. These categories coincide largely with rheme and theme.

The just and correct conclusion about the presuppositions underlying this system are that conditioning is a tool, perhaps, the first tool which set man upon his fantastic voyage in search of intelligence. In this sense, all supplements to the differential between the expert model and student performance are conceived in terms of tools for discovery. In a mathematics session the same analysis of student misconceptions reveals that the system recognizes two types of knowledge 1) a competence and 2) a performance which is linked to symbolic representation or expression. In language exercises, the interface between competence and performance is too tight to reveal these two separate domains of knowledge. However, the mathematical model is informative: the student performance may reveal a consistent misconception in the ideal paradigm regarding probability which can be separated by the microfeatures from a confusion in symbolic representation by its distribution in the student responses or model. In language arts, the student performance often reveals that the paradigm is incomplete for lack of skill in tool manipulation.

The significance of the CASE system is that all of the complex elements of the desired lesson need not be included in a single program or even programming language. The much desired graphics or interactive video can be controlled from a module, as can be the complex set of databases necessary for language acquisition.

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Education from Kindergarten through Post-Secondary and Beyond

A SCIENCE CURRICULUM EMPOWERING CITIZENS FOR LIFE, LIVING, LEARNING AND WORKING IN A TECHNOLOGICAL WORLD

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The time has come to recognize that an education in the sciences for today's world must be different from the 200-year-old curriculum model now in place. This is why so many of the national reports on the reform of science teaching include the phrase "for the 21st Century" in their title. Traditional science curricula are being viewed by critics as packages of mediocrity--placing the "nation at risk."

My position is that today's science curricula are for the most part functionally inert and fail to serve either the citizen or society. They do little for conveying an understanding of the ethos of modern science or of the culture or civilization which have been largely formed by achievements in science and technology. Little in the teaching of science is focused on life, living, learning and working in the real-world of human affairs. What is taught leaves students prisoners of their own knowledge. To escape these intellectual and social constraints will require a new vision of science teaching supported by a curriculum that is not like that of any other period in our history. As we enter the final decade of this extraordinary century characterized by achievements in science and technology we are throttled by a science curriculum that is philosophically of a past century.

Kenneth Boulding, an economist and a former president of the American Association for the Advancement of Science, describes recent changes in our society as a "cultural mutation." However, new goals and the creation of a supportive curriculum for this new age have not emerged after a decade of criticism and the bashing of schools and teachers.

The seriousness of the situation is evident in the need for President Bush to call the first ever summit meeting to formulate a new set of national goals. Education in the sciences was targeted for special consideration.

Where do the goals and the supporting curriculum now in schools fall short? Traditionally, science teaching goals have been derived from the sciences as disciplines. Objectives are described in terms of the practice of science, for example, "to think like a scientist," "to do science," and to apply "the scientific method," and to foster values "internal to scientific endeavors," such as intellectual honesty and validity of data. Laboratory exercises are designed a preprogrammed routines presumed to foster and understanding of what is meant by research. It is assumed that science can only be understood by learning the technical language scientists use to report research findings to their peers. The language is discipline bound and a new language must be acquired in each science course. Typically, science textbooks used in the middle and high school years contain one to three thousand terms--words the student has never seen before, never heard pronounced, has never used in a conversation outside of class, and will never use again after next week's examination. It's not all bad--science textbooks are among the most beautifully illustrated dictionaries available. The subject matter of science courses is presented in terms of individual disciplines, failing to recognize that disciplines as independent entities have been replaced by tens of thousands of research fields.

Last fall most science teachers introduced their course with the statement--"in this course you will have to learn to think." After the first test all alert students will recognize it is dangerous to your academic health to think--better to just memorize. Surveys of science teaching in the U.S., sponsored by the National Science Foundation, revealed that the major reason students dislike science is that there is "too much to memorize." Science is taught as a vocabulary and this is the way it is tested. Understanding is sacrificed in the interest of terminology, facts and coverage.

The most common question asked by students in science courses is--"What good is all this going to do me?" and the answer they typically get is "You will need to know this in the next grade or in college." A more appropriate answer would be "these terms are sometimes used in the practice of science by a researcher, this is the reason they are called technical terms. Walter Massey, a recent president of the American Association for the Advancement of Science, has given the following advice to President Bush: "Any science advisor who cannot explain to you, in language you can understand, important scientific and technical issues because they are too technical should be immediately replaced." (Science, 1989).

For 200 years the subject matter of precollege science courses has been selected with the view it should represent the traditional structure of a specified research discipline and be career oriented. As such, courses should be academic, college preparatory, rigorous and discipline bound. There was a time during the 1700s and 1800s, when less than 15 percent of students completed high school and a smaller percent entered college, that a career rationale for precollege science teaching might be justified.

The current quest for the reform of education in the sciences is a rejection of the traditional and outmoded curriculum that now characterizes school practices.

Over the past seven years there have been more than 300 national reports on the condition of education in the U.S., a majority of which identify education in the sciences as a special concern. There is broad agreement among these reports that a society and an economy molded and driven by advances in science and technology demand that every citizen has an understanding of science and technology and the role they play in human affairs and social progress. The curriculum goals recommended are those that consider science, society, the individual and technology as an integrated system. The criticism of conventional goals is that we can no longer afford a science curriculum that isolates students from their own culture and limits their active participation in the affairs of a science/technology society. The science curriculum now in schools is perceived as not rich enough in cognitive and social factors and in subject matter to empower citizens for life, living, learning and working in a modern science/technology based democracy. Furthermore, science teaching fails to provide students with the learning skills for dealing with changes fomented by the ever advancing frontiers of science and technology.

These perspectives are in contrast with the science curriculum improvement courses developed during the 1950s and 1960s, a quarter of a century ago. At that time the rationale was that precollege science courses should reveal the structure of particular disciplines in their historical and classical form emphasizing modes of inquiry presumed typical of research endeavors. The personal/social implications of science achievements were not considered nor was there a serious treatment of science and technology as an integrated system. These "innovative" courses were designed as basic to career preparation for gifted students aspiring to a future in scientific research and would do no harm to all others who might be enrolled in science courses. The current thrust is for science programs designed to empower all citizens with the capacities for dealing with the affairs of life and living and for promoting social and economic progress, as well as improving the quality of life.

The reform movement of the 1950s and 1960s placed great emphasis upon scientific inquiry as the way of knowing. The current reform movement recognizes the importance of inquiry as a way of validating information but considers knowing what to do with what one knows as of equal or greater significance. Being well informed is not sufficient, the typical science curriculum is overloaded with facts that lead only to intellectual bankruptcy, failing to empower students in the practical reasoning skills essential for resolving personal/social or real-world problems with a basis in science/technology. These are the skills recognized as "higher order thinking skills" that make it possible to relate quantitative information in qualitative contexts. Students recognize this limitation by repeatedly asking: "What good is all of this stuff to me?" There is little error about information of the sort found in science courses--it simply is not rich enough in selection and context to educate citizens to deal with the human and social affairs characteristic of a science/technology molded culture.

However we examine the teaching of science in the nation's schools over the past 200 years it has remained aloof from society, even though in recent years research in science has been more socially than theory directed. A result has been to create a citizenry now described as scientifically and technologically illiterate.

There are a substantial number of persons, scientists, educators, and parents who seek to perpetuate and reinforce the very curriculum that has given rise to the charge of placing "the nation at risk." These are the persons, though perhaps unwittingly, who feel that the traditional science curriculum is good enough and the problem is simply that teachers over the past two decades have messed it all up. Their solution to the problem is to lengthen the school day and year, make courses more academic and rigorous, pump up testing programs, bar students from extracurricular programs and athletics if they fail to "score above the average" on assessment tests, require more science for high school graduation, demand more homework, and never ask the question to what end. This approach reminds one of the chicken farmer who paints the hen house to improve the egg laying quality of the hens. If we are to enable future generations of young people to use knowledge from the sciences and technology to advance human potential and effect social progress, a wholly new science curriculum will need to be created.

A first step is to identify a set of life goals, that can be validated in terms of their meaning for personal development, for sustaining a viable society, fostering a democratic way of life, for maintaining a competitive position in a global economy, and that are in harmony with those of modern science and technology. Goals of this sort would move the teaching of science from its current emphasis upon the practice of science within a discipline-bound conceptual framework into the context of the culture and the service of science and technology to human affairs and social progress. This is not a new educational concept, it has been debated for the past 400 years. Roger Bacon in 1620 wrote: "The ideal of human service is the ultimate goal of scientific effort." To achieve this Bacon would choose educational subject matter "which has the most to offer for the welfare of man" (Dick, 1955). Benjamin Franklin, in 1747, writing the proposal for the founding of the American Philosophical Society described its purpose "to promote useful knowledge of science; to the benefit of mankind in general" (Franklin, 1743). As we enter the last decade of this century, the issue is again raised as to whether we are to promote the teaching of science that will empower all citizens for informed participation in a science/technology based society or do we continue to teach science as a career oriented subject for the select few?

Following the education summit meeting called by President Bush, the National Governors' Association formulated a set of national goals for science teaching. They are briefed as follows: "preparation for responsible citizenship," "further learning," the ability "to reason, solve problems and apply knowledge," and "to adapt to change." (National 1990). All of these objectives are oriented toward making science operative in human experience, rather than exclusively for the practice of science.

To bring about the changes in science teaching portrayed in the Governors' statement of national goals will require the present curriculum to be decontextualized and a reassesstment made of all that is known in the sciences and technology to create the new curriculum. This will not be easy, it is a matter of serious study and research. The volume of information in the sciences and technology is tremendous. Since the early 1900s traditional disciplines have been fractionated and hybridized resulting in 40-50,000 highly specialized research fields represented by over 70,000 journals. There are 20,000 journals in biology alone. Then there are 400 years of accumulated research and careful observation to consider. And we should recognize that science and technology are knowledge areas with moving frontiers. The selection criteria from this mass of knowledge are found in descriptions of life goals. The focus is on knowledge likely to progressively increase human potential, to foster social progress, and serve the common good. It is likely that information from a variety of research fields never before represented in traditional science courses will emerge.

A personal/social context for science teaching will require a broad range of intellectual skills for processing information, already recognized as "higher order thinking skills." These are skills associated with problem solving, decision making, forming value judgments and considering ethical and moral issues as they exist in the real world. Practical thinking involving science and technology also includes considerations of risk, uncertainty, probability, human dimension, and a recognition of the limitations of science. An understanding of scientific inquiry allows one to recognize the validity of knowledge. Higher order thinking skills are essential for using this knowledge in social and personal contexts. To empower students in the proper use of knowledge also requires students, among other attributes, to be able to distinguish evidence from propaganda, probabilities from certainties, rational beliefs from superstitions, science from quackery, data from assertions, science from myth and folklore, fact from fiction, and theory from dogma, among other attributes.

Human and societal problems can seldom be said to have a "right" answer or a single answer. People and nations operate from different value systems and cultural perspectives. Science and technology in the context of human actions are subject to political, gender, and economic biases; have different long - and short term responses that may involve arbitration and trade-offs. Sometimes no action may be the best response.

Scientific literacy in the context of science, technology, society, culture, and the individual as an integrated system differs from that of conventional perspectives. Traditionalists view scientific literacy as a bag of facts about science which all people should know such as: what is an electron?; why are days shorter in the winter?; what is a meteorite?; what is the source of food for plants?; whether or not the sun is a star?; what is a light-year?; and much more. Modern perspectives view scientific literacy as cultural awareness, an understanding of the place and significance of science in advancing personal worth and fostering the general good; it is a style of thinking based upon valid information and the willingness to make use of it in resolving problems. A scientifically literate person expects change not only in the sciences and technology but in all human affairs. Scientific literacy is a form of belief, a personality quality that fosters the adaptive capacity of individuals. Scientific/technological literacy is the ultimate achievement of enculturation in our society, empowering the individual for life, living, learning and working in the modern world as an enlightened and responsible citizen.

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Science, September 1, 1989.

STS-THE NEXT GENERATION-RESTRUCTURING THE SCHOOLS

by Paul C. Jablon, Phd. and Terry Born

At the fifth annual Technological Literacy Conference in Washington, D.C. this past February we were facilitating a workshop on restructuring the curriculum. In attendance were 40 educators from a variety of backgrounds, ranging from elementary teachers to college professors and including consultants and museum educators. They represented a wide spectrum of racial and ethnic backgrounds, working in urban, suburban and rural areas throughout North America. Contrary to expectation for an STS conference, they had a high percentage of women and included a wide cross-section of academic disciplines.

Research had led us to a document entitled "What Makes a Unit of Study STS" which appeared in *The National STS Network Leadership Resources Book (S-STS 1989)* which was developed in 1985 at Penn State by a task force put together to design a set of guidelines for STS instructional modules. Our search had identified this list as reasonably comprehensive, yet workable. The list is included in Table 1, below.

TABLE 1

What Makes a Unit of Study "STS"?

1. Responsibility: The unit develops learners' understanding of themselves as interdependent members of society, and society as a responsible agent within the eco-system of nature.

2. Mutual Influences of S, T and S: The mutual influences of science, technology and society on each other are clearly presented.

3. Social Impact Focus: The relations of technological or scientific developments to societally relevant issues are made clearly, early, and in compelling ways to capture attention.

4. Balance of Viewpoints: The unit presents a balance of differing viewpoints about the issues and options, without necessarily trying to hide the teacher's perspective.

5. Decision-Making: The material engages the learners in developing problem-solving and decision-making skills.

6. Responsible Action: The material encourages learners to become involved in personal or societal action after weighning trade offs among effects drawn from various scenarios or alternative options.

7. Integration and Personal Standpoint: The material covered helps learners to venture beyond the specific subject matter to broader considerations of science, technology and societal values/ethics.

[from The National STS Network Leadership Resources Book (1988)]

Participants in the workshop had the opportunity to put these guidelines into effect by collaboratively imagining how an entire school structure would function if it were based on these criteria. The groups, containing 5-7 participants were self-selected and only one, a group of elementary educators and supervisors was homogeneous in composition.

After twenty minutes of heated discussion they were asked to report back to the main group. Recommendations were greeted by enthusiastic suggestions for extensions and teachers eagerly shared positive experiences they had had in using particular criteria within their classrooms.

"Responsibility" as described by the STS guidelines involves the educators' responsibility to create learning situations, activities and environments that instill in students the concept and understanding that they are part of and responsible to an eco-system. Workshop discussion established that teachers can foster interdependence through programs which emphasize the correlation of disciplines* (Miller, et al, 1985, Dodd, 1984), especially non-traditional groupings such as science and English or math and social studies. This translated to the key word, interdisciplinary. Students need to do projects that have an impact on the community and therefore need to spend some of their school time out in the community (Burr, 1935; Coleman, 1987).

As participants delved more specifically into the interdependance of science, technology and society they refined interdisciplinary to connote more than one teacher from several disciplines working simultaneously with one group of students in the classroom. They felt that if we, as exemplars, truly believed in the interdependence of ideas that we needed to practice what we preached. Yet integrating disciplines is not always the natural way to cover state-mandated curriculum efficiently. The offered solution was a restructuring of curriculum according to themes, within which segregation by discipline becomes unnecessary and integration really occurs as the students produce a final project based on the subject matter they have studied (Jablon and Born, 1988).

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*Note: Each of the strategies listed by the participant is referenced by the authors to citations that exemplify the core of the ideas presented.

The teaching of interdependence led the workshop to the concept of education as a force and tool of empowerment. With responsibility comes authority and tools for action which allows for empowerment of students. If students were to be empowered in activities, based on knowledge that allowed them the opportunity to act in the world, that empowerment had to come from equally empowered educators. This lead to a discussion of site-based management (English, 1989) including involvement of teachers, administrators, students and parents. The interdisciplinary nature of a Curriculum of Responsibility further enhances empowerment. By allowing students to select courses that have themes and projects that are of interest to them they would naturally be influenced to become forces of "Social Impact" which was the second guideline that we discussed.

Everyone agreed that socially relevant issues are perfect themes, both as "integrators" of disciplines and, if presented properly, as compelling motivators. Though we were imagining ideal schools we tried to remain true to our experience of the typical student. No one was so naive as to believe that they could take a passive self-absorbed student and create an impassioned interdependent citizen in one term. That led to the suggestion that these programs or theme centered classes could be ongoing, with themes changed each semester, but strategies, interdisciplinary classes and project centered classes be ongoing. This would enable students to enroll more than once, yet offer them different course credit from one term to another.

A Balance of Viewpoints was an outgrowth that could be fostered by good team teaching with a team that includes students as well as teachers. "Decision-making" reaffirmed the idea of empowerment of students and teachers, including the classroom governance. The school needs to be a model for the classroom and the classroom becomes a model for students where they can experience healthy relationships with their peers as well as adults.

In order to give depth to problem solving and decision making skills, participants echoed our contention that psychology and sociology need to be infused as part of the subject matter at all grade levels. We can no longer simply be satisfied with teaching how things work and how people act but we must be able to understand and impart some of the reasons why.

Classes need to be action-oriented, which in turn, makes the whole school action-oriented in the community. The action must be one which goes out towards to community and, once more, instills in students a sense of empowerment.

At this point we would like to share with you, as we did on that Saturday afternoon, some ideas that we have been mulling over in light of the highly charged discussion and our own experience of running a program which utilizes all of the strategies and guidelines above. First, it has seemed to us that in planning for interdisciplinary, theme-oriented classes there are probably a limited number of broad concepts or themes and a set number of skills which cover most content areas. Concepts such as "the right of the individual vs the right of society" or "Ecosystems and homeostasis" cross all disciplinary lines. The process that one uses for writing a lab report is the same process one uses in writing an essay. The process employed by the creative scientist is similar to the "holistic" experience that a poet, musician or choreographer undergoes when the spark of inspiration is first honed and molded into a concrete piece of art. Schools might do well to try to describe and identify these concepts and skills and use them as the basis for alternate exit criteria for graduation.

In addition, if you are fostering academics by administrators and teachers telling students it is a good idea to do well in school, it might be more logical to also begin to foster academic success between the students themselves. Students regularly have very negative neighborhood peer groups (Turner, 1983), certainly in urban areas, and creating academic situations, centered on interdependence can take the strain of motivating towards achievement from the teacher and on to students themselves. By creating classes which need to learn academic subject matter in order to create projects of relevence in a social, technological and scientific context you place the responsibility for consistency in attendance and performance on students. They become responsible for each other, and most importantly they become the cheering section for their fellow peers.

Third, interdisciplinary academic material needs to be "Personalized." The psychological motives that drive their conflicts with their families, friends and romantic partners are almost identical to the motives that drive international conflict, economic issues. If classrooms became the playing field of these "personal interactions" through role play and simulations, teachers can be simultaneously addressing adolescent needs and making the analogy of these interactions on the global level.

We [illegible] a videotape, "We're All In It Together"(BONGO, 1990), about a program that [illegible] successful in changing negative patterns of at-risk adolescents. Students [illegible]me regular in their school attendance, eliminated their cutting of classes [illegible] their academic subjects while creating an alternative peer group.

Th[illegible] were surprised to see that the "ideal" STS school that they had ima[illegible]sted at school sites where the BONGO Program had been implemented, b[illegible] study of BONGO showed remarkable success (Jablon, 1989) with at-risk students.

As participants left they began to believe that it is perhaps more than coincidence that the influx of STS into the education world over the past ten years has been accompanied by the seemingly unconnected advent of support for student and teacher empowerment, collaborative learning, Sizer's "depth vs scope" and community involvement. As American educators use the dynamic strength of the matrix these educator's grappled with on this February afternoon, they could lead our school systems into an ecosystem that would be self-correcting and self-sustaining.

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K-12 STS AT CRESTON: A TEAM EFFORT

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About six years ago Creston Middle School (through participation of Curt Jeffryes) became involved with STS through the Iowa Chautauqua Program. Dr. Robert Yager told about a dream he had about STS becoming a part of every science classroom in the state of Iowa. We began having a similar dream, i.e., that Creston would adopt STS "system wide."

But why move to STS -- What was special about it? The answer was simple -- there was a need for change and STS seemed to fit the need. Most of the teachers found the books inadequate; there were not enough hands-on activities; and there were issues the teachers felt should be addressed but with which they were not comfortable. It seemed that STS was a needed response; it meant organizing a team effort to meet the science education needs in our district. STS as conceived by the Chautauqua Program has several common features. These include the following:

1. the identification of problems with local interest and impact;
2. the use of local resources (human and material) to locate information that can be used in problem resolution;
3. the active involvement of students in seeking information that can be applied to solve real-life problems;
4. the extension of learning going beyond the class period, the classroom, the school;
5. a focus upon the impact of science on each individual student;
6. a view that science content is not something that exists for students to master on tests;
7. a de-emphasis upon process skills--just because they represent glamorized skills of practicing scientists;
8. an emphasis upon career awareness--especially careers related to science and technology;
9. opportunities for students to perform in citizenship roles as they attempt to resolve issues they have identified;
10. identification of ways that science and technology are likely to impact the future.

These characteristics attracted key teachers. They saw science when cast in such an STS mold to be an exciting way to revise the science curriculum, to change teachers behaviors, and to test student learning.

It was fine to have a dream, to see a need and to find an attractive model for making the dream a reality and the possibility for needs fulfilled. However, nothing usually happens if you do not first have a plan for implementation and a timetable to work within. The plan developed at Creston involved four areas. They were:

1. selling the staff,
2. selling the community,
3. involving the local administration, and
4. continuing the involvement of The University of Iowa and/or its education department.

The first part of selling STS in a school district is in showing the staff and administrators that you have something worthwhile that will improve the state of education in your district. You must remember that many teachers are naturally skeptical -- they have heard too many "cure-alls" in their careers which haven't worked.

You have to prove to your staff that what you have is truly something better. In Creston it was found that simply sharing what was going on, letting the students show their excitement, and publicizing positive parent responses can be important avenues. In Creston people began to ask questions slowly and to show interest in what was going on relative to STS in middle school classes.

It is important to be patient as lasting change usually occurs slowly over a long period of time. At the same time it is important to have good timing and to be ready to move when opportunity presents itself. Interest in STS spread into the elementary school and the high school.

The second part is selling the community on STS. It is impossible to have a good STS program in a school without the support of local industry, business, and governmental agencies. When seeking assistance from the community, it is important to know what resources each has and the capabilities they have collectively in helping you develop your programs. Take whatever resource a business has to offer and avoid being pushy. In time their involvement will often grow. Also try and remember to recognize publicly the resource for what it has contributed to the new school effort.

The involvement of all local administrators was the third part of the plan. It was surprising that selling Creston administrators on STS was relatively easy to accomplish. They quickly recognized that STS could help improve science education in our school district. They were informed about the dream regarding the potential of STS. Soon they became strong partners in helping STS grow. In one sense the administrative team was most instrumental in seeing STS grow into a total district effort. The support individual administrators gave took several forms. First, they offered encouragement to keep pursuing our goals and the staff to improve professionally. Secondly, they constantly encouraged other staff members to become involved and fostered this by hosting an awareness workshop. Finally they wrote letters of support which were critical in bringing an Iowa Chautauqua Program Workshop and a Summer Science Institute to Creston for staff development. Without the interest and support of the local administration, STS would never have grown to its current level of commitment in Creston.

The final part in bringing STS to Creston was the involvement of The University of Iowa. The Iowa Chautauqua Program and the Summer Science Institute were two key factors in making Creston an STS district. It may be the first in the nation to go STS "all-the-way."

It is nice to have a dream, cooperation from administration, and the support of the community, but without the involvement of higher education and/or state education agencies, it is likely that nothing would have happened in Creston. The move to STS has been an example of science in action. There were initial questions, then ideas or possible responses to the ideas, and finally evidence collected concerning the actual successes of the responses/activities that were tried. Assessment has been central to the advance of STS in Creston.

The University of Iowa provided leadership, course offerings, enticements, a communication network, and a theoretical and statistical framework which made curricular change possible. The Iowa Chautauqua Program provided a mechanism for the change. It is a mechanism and a process that can be used in other districts.

What is clearly evident is that bringing STS to Creston was a team effort. It started with the dream of one teacher and grew into a large team effort involving many different players. It is exciting to be a player in this effort to provide a better science program for the thirteen years of schooling for all pupils enrolled in the Creston schools.

IN SEARCH OF THE ENVIRONMENTALLY CONSCIOUS SCHOOL

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In today's society there exists a strong need to develop a sense of awareness concerning the role of the individual in protecting the environment. With an ever growing probability that our natural world is on the verge of destruction; an increasing population to further consume resources and create a larger solid waste problem; and a seemingly uncaring business community furthers the "convenience over conscience" ethic; the role of education are paramount to the salvation of the environment. If the educational community is to become the leaders in this change it is necessary that schools become environmentally conscious themselves. It is in no manner my intent to cast any blame upon individual school districts for practices that occur within their walls. It is my contention that they are simply responding to problems in the identical manner that any business does. However; the school is given an opportunity that no business is offered. They are offered the opportunity to change not only practice, but also perceptions on the role of the individual in saving the environment.

In Search of the Environmentally Conscious School sets out some very simple points of where school districts often act in a less than environmentally conscious manner. Often times their actions are out of necessity either due to monetary constraints or due to the volume of services that must be offered by them. Each of these areas is asked in the form of a question assuming that the environmentally conscious action *exists* in the school. It is my hope that each of us can answer the question with an affirmative. For those of us who cannot, I explain the need for change in the practice.

My school does not use mimeograph copiers. The process of mimeograph copying is a "wet" process by which a solvent (Methanol) allows a copy to be made from a carbon master. In this process we have exposure to a toxic chemical in rather large amounts. While the process itself actually places very little of the chemical on the paper, in the school setting where the mimeograph is used, a large volume of treated paper is generated. Thus the exposure is great.

Methanol is a poisonous liquid which is fatal if swallowed and is extremely dangerous if inhaled. While the chance is remote that Methanol would be swallowed, there is no doubt that because of the process used in mimeographing that the fumes are inhaled. All teachers have seen students "sniffing" their dittos. In doing so they are in affect poisioning themselves. The environmentally unconscious act lies in the fact that the paper once treated is no longer recyclable and is actually itself toxic. Schools which still use this process will be faced with a large disposal problem in the near future as landfill regulations grow increasingly stringent. Also in many buildings, due to attempts to save energy, there is very little movement of air within the building thus trapping the fumes within.

Each of the rooms in my building has a separate thermostat to control the temperature in that particular room. All schools attempt to control the use of energy within their buildings. In most cases this attempt comes out of a need to conserve monetary resources rather than energy resources. In most older buildings there exists little if any control over the temperature of individual rooms. We often find that the room that is cold in the morning is excessively warm in the afternoon. The physics behind this occurrence, especially applicable to second floor rooms, has been known for centuries; yet the implementation of how best to use it is still often lacking. The room which is cold in the morning is heated throughout the day. As heat rises, the radiator in that room continues to force heat into that room. The usual response to an overly heated room is then followed. The window is opened allowing heat to leave, so more heat can be added to the room , and the cycle goes on infinatum. The use of climate controllable rooms would offer expense at the onset; but offers savings, both monetary and environmental, in the long term.

The heating/cooling system in my building is efficient. This is an extension of the previous point. In older schools often we often find that the once very efficient heating./cooling system is no longer as efficient. With advances in h/c technology and the general aging of the school itself we see an increased amount of energy usage through the years. Rooms or sections of the building are often found to be drastically different in temperature. This may or may not be due to an addition to the building which taxes the system or due to a central temperature control which dictates energy use based on only a segregated portion of the building. As we near the beginning of the twenty-first century, we are increasingly faced with a diminishing supply of energy resources. Schools should be encouraged to address the issue of energy consumption within their buildings.

My school has a "RIGHT TO KNOW" program describing possible health hazards within the building. New York State has mandated that every school or business where possible toxic hazards may arise offer a "RIGHT TO KNOW" program for all employees. In this program the employees are made aware of possible health hazards and precautions for their work place. Significant concerns are addressed such as the presence of asbestos in the building materials of older buildings and the chemical hazards of science laboratory. While these concerns are extremely important, another issue which I feel is of even greater importance is seldom addressed, indoor air pollution. While these programs offer to the schools solutions to concerns of operating practices and removal of toxic substances, they fail to address the need for change in those practices which create possibly even greater hazard to employees.

The age of my building is less than 10 years. The answer to many of the energy needs of a building can often be addressed by using better technology in the construction and operation of the building. Advanced means of insulating a building as well as climate control can decrease energy consumption a great deal. As in any decision based on new technology, there often exists off setting complications. This is the case with newer "air tight" buildings. As we seek a means of limiting the amount of heat which is allowed to escape from a building we try to limit the air flow from the building to the outside. As we become more efficient at this we trap increasing amounts of the air within. This exacerbates the environmental concern of indoor air pollution.

In order to make our buildings more energy efficient, new building materials have been designed to increase R-values and limit energy transfer by conduction with outside openings. This type of technology entails the use of chemically treated materials and the introduction of chemicals in the form of gas into openings to form insulating layers. These products are extremely effective in limiting air exchange and thus energy loss, but they will, as any material, tend to release the chemicals that make them up into the air. As these chemicals are released into the air through off gasing they are trapped in the air within the building. Chemicals such as Formaldehyde, Carbon Monoxide, as well as the other chemicals left from operating practices are now allowed to be breathed in.

I notice a smell in my room after it has been cleaned. Schools have a need to ensure that sanitary conditions are maintained. In addressing this need they are often forced to use cleansers and solvents which are in high chemical concentrations. Often times these products contain chemicals which are quite hazardous. This hazard is once again escalated by the fact that the building is being designed for minimal air exchange, so these chemicals are allowed to increase in their concentration. Chemicals found in some of these products are Xylene, Toluene, and Benzene. All of these chemicals themselves are a hazard, but when combined and concentrated by the closed environment of the building, they become a great concern.

A considerable amount of my building is not carpeted. We see a further increase in the amount of indoor air pollutants present in new building when these buildings are carpeted. The process by which carpets are designed and made are for maximum durability and protection from staining. Both of these design features are accomplished with the use of chemical additives and processes. We ourselves are familiar with the smell of new carpet and furniture, which is treated in the same manner. This odor we smell is the process of off gasing occurring. If we think back we would realize that this is by far the strongest of odors we smell from our commercially made products. As a school attempts once again to add to the energy conservation and aesthetic value of its buildings, it furthers the introduction of chemical pollutants to its air. We now see increasing levels of chemical sensitivity among students and adults. Even levels of Carbon dioxide from respiration when trapped with the building can increase to a level where its effects are a limiting factor. In the quest to reduce energy consumption we have created another hurdle which must be crossed in order to raise environmental standards within the building.

My school allows for "open lunch". The problem of indoor air pollution is often furthered by schools imposing a "closed lunch". In this case the students are not allowed to leave the building during their lunch period. By not allowing the students to leave the building, they are being denied the opportunity to escape from the chemically treated air of the school.

My school source separates its solid waste. Our society is increasing faced with the future of limited landfill space. The plan of action we need to follow is to limit the amount of recyclable waste which enters the landfill system. By source separating solid waste this can be accomplished. The school should approach this point from two avenues. First, they themselves should set out to limit the flow of solid waste into the system. This is accomplished through various methods of separation and recycling. Secondly, the schools, through their example, should educate their student population as to the need for source separation and recycling. In doing this the school has the opportunity to change attitudes and perceptions of the individual's role in saving the environment.

My school attempts to recycle "office-grade" paper. Office-Grade paper is that paper which has not been chemically treated by a "wet" process. This type of paper is Xerox-photo copies, notebook paper, any paper which is not completely covered by ink or other products or does not have another chemical process affixed to this. An example of this is an envelope. The envelope itself is completely recyclable except for the portion of the envelope which has the "glue" on it. If this portion is removed the envelope is considered Office-Grade paper. The schools generate large amounts of high grade recyclable papers. If there is a conscious effort to separate these products from the waste stream there will be a significant savings to that system.

Many schools also fail to see the great savings which can arise from a Office-Grade recycling program. First, by limiting the amount of waste which is generated and must be taken away by a hauler, they will lower their cost of garbage being picked up. Also, in many areas of the country Office-Grade paper is purchased by recycling companies for its high quality. While this product is often only purchased in large amounts, the school system generates appropriate amounts for this to help offset the cost of the program.

My school uses recycled paper. The use of recycled paper is another way by which the school can assume the role of a change agent in environmental concerns. While the cost of recycled paper is higher then the current cost of their paper supply, the message that is sent by the school is great. By saying that they are willing to go to a slightly great expense in order to raise their environmental standards the schools have the ability to set goals for other businesses to follow.

My school does not use styrofoam and plastic in their cafeteria. Due to the fact that in many cases there exists a situation where fiscal constraint is necessary within a school district, we now see a trend where many districts have turned to the use of styrofoam and plastic serving dishes and utensils. The cost of these products is considerably lower than the necessary personnel which would need to be hired in order to clean the traditional glass and metal dishes and utensils previously used. With an increasing concern for the state of our landfills and the fact that products made of Polystyrene (styrofoam) are non-recyclable, this trend needs to be halted. Even a change to the use of paper products, would help to reduce the generation of non-recyclables, would be a move in the right direction. The increase in the cost of paper dishes over Polystyrene dishes is somewhere in the neighborhood of 1.5 cents per item. The use of paper or glass along with metal utensils combined with a source separation of food waste and recyclables would greatly decrease the amount of solid waste generated by the food service system. It is my estimate that just the reduction of the waste needed to be hauled to the landfill would be sufficient to offset the increased cost of the paper products and the personnel needed to clean the metal utensils.

In my school district environmental education is mandated. It is vitally important that the students who leave our high schools and enter the voting public be aware of environmental concerns. Only through some sort of environmental education can students be educated about the need for change and the role they have to be agents of this change. Most districts do not have a mandated course in environmental science. If one of the goals of our schools is to prepare graduates to act as vital members of our society through their right to vote and through responsible action, then it seems to me that we are falling short of this goal if those who graduate from our schools are lacking in the knowledge of how to vote and act responsibly on these issues.

My school district is responsive to environmental concerns which face my community and others. Schools have the ability to be leaders in the development of awareness of environmental issues which confront all communities by addressing these issues in their curriculums when discussing current affairs. Whether in the Social Studies curriculum discussing procedures in American Government, the Science curriculum when discussing energy resources, the Technology curriculum when discussing design of homes, trhe Home Economics curriculum in discussing the use of cloth diapers over disposable diapers in a child development course or the English curriculum when discussing how to write persuasive letters, the schools can lead in the generation of critical thinking among its students on environmental issues. In this way the school is responding to the needs of all communities by making their students aware of the need for global changes as well as changes in their own community.

My school district does not look at financial costs over environmental "costs". In assuming its role as a change agent for our society each school district should seek to always respond to the environmental "costs" over financial costs. With increasing budgetary constraints on school districts, especially in those small, state-aid dependant districts, very difficult decisions need to be made. A school which puts fiscal concerns aside to answer the need for environmental consciousness should be applauded and supported financially for its stand. If we, the public fail to encourage environmentally responsible actions, then *we* ourselves are responsible for the mission of the school not being accomplished.

The search for the environmentally conscious school will continue, for in no way can we predict the future problems that will face our world. Our schools need to develop the flexibility to be able to adjust their practices to meet the needs of natural world. For through their adjustment they will lead to the readjustment of societal attitudes and perceptions toward the environment.

TECHNOLOGY-ENHANCED CLASSROOMS: WHAT GOOD ONES LOOK LIKE

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They are really there. Computers built into desk tops, as accessible as crayons. The Open School in Los Angeles is an important model of innovation, ready for use in the present and marking the way into the future of technology-enhanced instruction.

How does this school differ from other classrooms where attempts have been made to integrate technology into the curriculum? Our observations, photographs and interviews with students, administrators, teachers and technical advisors at the school as well as published reports (O'Malley 1989) led us to develop a CHECKLIST OF CRITICAL ELEMENTS present in this system that mark it as a dynamic learning environment.

This article includes the identification of 15 critical elements distributed across 4 categories. Readers should find the listing useful as an "ideal" model for assessing their own technology programs as well as a guide for directing further development and planning of technology-enhanced instruction.

CRITICAL ELEMENTS CHECKLIST

1. The Physical Environment
    - Adequate space/student ratio
    - Activity centers
    - Networked computers built into desk tops
    - Specific and limited set of application software
2. Philosophy
    - Open Classroom (Informal Classroom)
    - Small-group learning
    - Learning contracts

Peer-group learning
Shared decision making (administrators, teachers, parents).

3. Curriculum
   Theme-oriented
   Discovery Approach (experiential learning)

4. Instruction
   Team-teaching
   Community volunteers
   Full-time technical expert
   Paid summer or release-time learning opportunities

Commentary on the Checklist

Three other models have been described in the literature for integrating and implementing computers in education. Cory (1983) reported "A 4-stage model of development for full implementation of computers for instruction in a school system." Her four stages included "getting on the bandwagon", "confusion", "pulling it together", and "full implementation". Within each stage, 6 attributes were named: Hardware, software, staff development, computer-assisted learning, computer literacy, and attitude.

Gray (1986) also reported on "A four-stage model for integration of microcomputers in teacher education." Within each stage, he described 4 components: Hardware, software, staff development, and CAI/CMI (Computer Assisted Instruction, Computer Managed Instruction).

Langhorne et al. (1989) reports on "The phases of instructional computing: Literacy through integration." They list 3 phases-getting on the bandwagon, the shotgun approach, and planful (sic) integration. Each of the 3 phases are evaluated in terms of 5 components: Place of computer in instruction; program planning; software; hardware; and staff development.

How does our checklist compare to these 6x4, 4x4, and 3x5 matrices? We believe the observation of technology use in classrooms should begin with the most obvious but often most overlooked part of a class setting, namely the physical environment. In our ideal setting, we found adequate space in the computing environment for comfortable use of accessory learning materials. A classroom designed for 30 children is too small for 30 children and quantities of hardware, software, and computing peripherals.

One solution to the space problem is the redesign of the student's desks. At the Open School, the computers reside beneath the surface of the desks hidden from view but plainly visible through plexiglass windows. The keyboard and mouse slide easily out of the way when not in use. All the machines are part of a classroom network. Children may sit at any station and call up software and their own files and be ready to work. As for the software, it is limited to a word processor and a drawing tool and one or two other teacher-developed programs using hypercard.

In addition to the recessed machines, a small number of computers standing on desks (but also part of the network) serve as one of six major activity centers in the room.

The philosophy of the school is the second checklist category. Our ideal site followed a philosophy of open education. Gross (1970) reported the four operating principles of the open classroom, all of which we saw operating at our observation site. First, the room itself was decentralized. Two large classrooms connected by a common work space was open to all 50 children. Second, the children were free to explore these rooms individually or in small groups, guided by learning contracts, but generally choosing their own activities. Third, the classrooms were rich in learning resources including computers, books, concrete materials, work sheets and other media. Fourth, the teachers and their volunteers worked most of the time with individual children or small groups. Many of the groups were of mixed age/grade children where opportunities for peer teaching were explored. We did not observe the same material presented to the class as a whole.

Commentary from staff, administrators and teachers indicated an underlying shared philosophy as well as shared decision making.

Curriculum is the third category and is described by the terms "theme and discovery oriented". Learning in our ideal classroom was rooted in the assumption that children wanted to learn and would learn through firsthand experiences. This discovery approach emphasized learning, not teaching; it focused on the child's problem-solving capabilities; and encouraged the children to communicate their discoveries to others (not just the significant adult). Theme oriented lessons allowed for the inter-penetration of various subjects and skills (especially in science and social studies) and gave children experiences with a connected view of knowledge in these areas..

Instruction is the fourth and final category. A variety of adults provided guidance for the children: Teamed teachers provided the classroom instructional leadership. Working closely with the teachers were a number of student aides and adult community volunteers. Their activities were supported and monitored by the teacher teams. A full-time technical expert provided support for the entire computing environment that served a population of 300 children in 5 two-room buildings. The technical expert was also responsible for preparing special software programs for use by the children. This software, such as a hypercard presentation, was designed specifically to meet objectives of the teacher-developed curriculum. Teachers themselves were prepared to use computing as well as other instructional strategies through release time during the school year or paid development time during the summer.

Conclusion

As the reader probably observed, most of the elements of our checklist were learning principles, not technological principles. We take this as a confirmation of the truism that the solution to the problems associated with technology in education will be found in a deeper understanding of education and not technology. The Open School represents an important model, a genetic pool, of educational innovation. We felt privileged to observe and report on this dynamic learning environment.

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SCIENCE EDUCATION FOR THE 21st CENTURY-A UNIFIED FIELD MODEL.

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The purpose of this paper is to outline a long-range approach to the science-technology-society literacy (STL) problem and which would also improve education in general. The idea is based on the need to break down the barriers which exist between the science and non-science educators by integrating science into various subject matter in a natural way. The misperceptions of the basic problems faced by the science community in encouraging greater and improved elementary school science are first discussed.

The last quarter of a century has seen a sharp deterioration in U.S. education as represented by the skills acquired as well as the performance scores on standardized and comparative international tests. This is due to insufficient support and also to the forces of social change. At the same time the U.S. has undergone relative decline in competitiveness in manufacturing industries with the emergence of Japan, Germany and Southeast Asia and the formation of the European Economic Community. Although a large part of the change evolved naturally from post-war rebuilding, a greater portion is that due to persistently low U.S. productivity levels. Increasingly, the rather dormant level of skill of the workforce is a factor as well.

The U.S. had previously enjoyed a comparative advantage resulting from a superior educational system (i.e. as quantified by the "Leontieff paradox"), whether due to its greater length of general education and/or the quality of training of its work force. Significantly, the illiteracy rate in the U.S. has increased to over 15% while that of other nations has increased, especially that of our main competitors. Japan for example is less than 10%. The labor force is becoming incrementally more capable overall due to mass college education, but not a pace commensurate with the requirements of modern society. In addition, product development are increasingly being driven by technological advances of shrinking time span, indicating the need for intensified R&D efforts. Demographics however portends an impending shortfall in the numbers of available engineers and scientists as the population ages and minorities and women become to represent the largest sources of new recruits into the sciences.

The drop-out rate among inner city youth, where the majority of the minorities reside, remains high and appears to be intractable. A five year $120 million program to stem the outflow recently concluded failed despite having brought all the resources deemed necessary to bear on the problem. Present reforms to upgrade education and mathematics skills in particular should improve the present generation of elementary and secondary school population if continued over the long term. Unfortunately many school systems lack the funds to implement the reforms adequately.

A marked illustration of the effects of the growing "educational lag" is the sizeable proportion of urban youth failing entrance level exams for jobs set aside for them in N.Y.City upon graduation from high school. Minorities, comprising a greater portion of urban youth than in the past, suffer most from inadequate schooling by the decreased traditional mobility education formerly offered. Several social factors act to impede their recruitment, including the recently noted lack of interest by these groups in pursuing sci-tech careers stemming no doubt from the long-term demands and relatively low payoff of a science career.

An important reason for upgrading our education is the steadily growing decisions on policy and funding the public must weigh which involve complex matters including technology which were formerly once left to appointed officials. The dual problem of increasing graduates interest in pursuing science careers and enhancing general STL requires a review of our cultural values and the direction they are heading. Sociological studies, such as those of M.Mead and more recently those of H.Stevenson, point out the latent bias against science and mathematics of parents and teachers of the elementary schools which no doubt reflects the feeling of the population in general. The science community's traditional response to the threat it perceives to support of research and to declining science-mathematics competency has been by a frontal assault on the government for financial support, as well as an intense campaign of grassroot "outreach" programs such as Summer institutes at colleges for high school students, science fairs, etc. The large Project 2060 effort of the American Association for the Advancement of Science (AAAS) intends to forecast the future knowledge required by students and then modify science instruction. Institutionalizing these programs should increase the almost monotonously constant rate of new entrants choosing science careers. For example, the American Institute of Physics reports a steady 10% of college entrants having taken physics in high school choosing physics as a major for the recent forty year span. The increase is estimated here at most some 10% which agrees with the general line of reasoning found in recent publications of Morris Shamos.

A review of the commentary of leading science spokesmen this dual problem appears to be based on misperceptions or "myths". A fundamental one is that stated at the introduction to Project 2060, "...our schools have failed our children". This implies that the burden is placed mainly on school administrators and teachers to produce the literate individual. It also suggests that the external environment, in which students acquire their attitudes and prejudices to education and society and meet the demands of additional social dynamics which enter the classroom, are of little relevance. In more affluent communities these external factors can often be minimized. In brief, the above quote fails to recognize that the home and society with its embedded values and peer pressures, form the basis for achievement. It also fails to account for the deficiency in resources available to most schools. One can hardly find a more rigorous screening process of teachers than that in New York City or its environs, but whose skills and dedication are challenged each day by bureaucratic overload and social factors.

A second myth is that significant progress in enhanced science education and STL is possible without improving education in general. The movement in theoretical American education of late has been towards developing critical thinking skills, following Bloom's taxonomy and upgrading the GED exam to reflect the change in philosophy. If successful this alone would provide the greatest benefit to science education as it relies on these same academic skills. The point is that science is not necessarily required to develop these skills, but at the same time science is a subject which, and this can not be stated often enough, provides almost all of the favorable social interactions deemed desirable in a classroom. These include providing challenge, socialization by group efforts sense of achievement, as well as encouraging initiative, discovery, and inquiry. Pupils thus armed with analytic reasoning and who are exposed to a continuous (acclimating) set of mathematics courses would be more comfortable with and should do better in mathematics and science courses. Only students seeking research or engineering careers need be instructed in a rigorous program of instruction at the earlier secondary school levels. It is felt here that the achievement of critical thinking skills alone would make students more receptive to dealing with science in school and out, and possibly enhance the levels of entrants into closely related areas. This would provide an increased skilled labor pool for jobs relying on increased technical savvy as well as increased judgment on public policy.

A third myth is that increased exposure to science and mathematics by itself will aid the competitiveness of the U.S. First, the expected increases to the R&D labor pool is realistically a few percent at most. Students generally have to borrow for their college and post-graduate education and seek lucrative fields to effectively repay the loans.

Science, besides being more demanding of skills of which students are less capable in, is not a low risk career if one seeks the fast track to success. The more important point is that competitiveness rests on the methods and attitudes of business and related regulations. The recent cooperative efforts resulting from selective revision of traditional anti-trust laws and an active government role at duplicating Japanese method of directed funding for future technologies are now in disfavor. Business itself is guided by short-term interests such as shareholder dividends and leveraged buyouts, which act against technological innovation. In fact, except for a short period at the end of the 1950's, there has not been a shortage of engineers or scientists due to the high efficiency of the nation's R&D sector and yet the decline in competitiveness. American business reduces R&D activities first when times are hard, as opposed to their international competitors who normally take the long-term view of investment. If business itself was more comfortable with mathematics and science they might demand more analytical capability from their applicants instead of having the business education curricula deemphasize applied science courses.

What of the increased magazines and books people subscribe to covering science subjects ? Such statistics I feel reflect the increased education level of our work force, the increased effect that sci-tech has on our lives, and for a small business element the need to have an increased knowledge of technology. It does not however translate to increased pool of researchers or engineers, nor has it meant something one might expect, such as increased R&D funding by American business in general. Business tends to follow "reverse engineering" and minimize the risk of new technology. One example is color TV broadcasting which RCA had to develop on its own before other U.S. firms would engage in.

An important factor which appears to be neglected in discussions of upgrading education is our changing value system. Earlier home life meant access to a radio or at most a family TV. Today's youth are heavy consumers and decision makers having increased awareness and freedom than ever before. This has increased access to and time for a wide variety of social activities. Significantly, this has spilled over into education. For much of the urban student population, they are in effect doing schools and teachers a favor by attending rather than the other way around. Secondary education and college level courses have been delayed by the need for remedial instruction. Interestingly, the Japanese have the effect reversed. In the U.S. the attitude is that college is necessary and becoming academic-minded can wait until then. Thus, the advantage gained by businesses in the past by hiring a high school graduate is now translated to more able, relative to high school graduates, but more expensive entrants to the work force.

The Japanese, as students of most Asian countries, are required to compete for each level of secondary school or face little choice or upward mobility in a career. The intensity of study effort, enhanced by parental guidance, increases the level of skill as it occurs at an earlier age. College in Japan is often used to "relax" from the strain of earlier effort. The loss of high school age study skills prolongs the time by which American students reach levels required by todays employment. Reading and writing skills of college entrants are compatible with those of their mathematics and science skills. As noted by a colleague, high school mathematics has become more rote in character which lends itself to the poorer student as other subject areas require more reading comprehension, insight and judgment.

This brings us to the prescription for enhancing the science competency of our youth which is also commensurate with what education should evolve into in the 21st century. The basic idea is to bring out the elements of science in related as well as more distant subject areas and which comprises the history of the U.S. as well as that of world history. A project might extend over several sessions having science and technology as part of the history, or culture of a region, etc. as appropriate. Examples such as continental drift, the Industrial Revolution and global warming each with major components of history, geography and economics as well as science and technological topics, relate to the overall life of a region. A study of the Industrial Revolution could include the change in the character of work due to mechanization as well as the basic principles of heat and temperature and the steam engine.

Some topics lend themselves to a broader coverage. For example, a subject which needs stressing in America is geography. In the course of a few weeks a region could be studied in the following manner. A region would be studied by looking at its formation, its climate and weather, and the resulting plant and animal life indigenous to the region. The geological aspects of particular areas could be introduced including plate tectonics and sea floor spreading to show how the country formed. With a brief look at magnets they could be made part of a model of the sea floor to graphically illustrate how plate tectonics was discovered. In addition this had profound effects on the ecology as for example when South America and Africa parted. For example, amphibians gradually became long-distant swimmers of increased lung capacity, which incidentally shows the workings of biological evolution. Climate would also be included to discuss the plant and animal life of the region. The region's environmental problems would be discussed based on today's living conditions.

The main point is that science need not be segregated out and taught in a separate lesson, nor necessarily be the central component of all lessons. The "Project India" for example could be a class effort in part where student work in groups or together to complete the description of life in India but also contribute some work of their own. Being that solar cookers are used extensively in the countryside where about 80% of the population resides, the idea of solar energy would be discussed leading to the radiation output of the Sun. Solar cells are good demonstration models for studying the effects of the Sun's radiation on materials including the skin, and in photosynthesis while a mention of the photoelectric effect would not be too advanced with seventh or eight graders learning about the atom. Monsoons affect the agricultural cycle and lifestyle of the citizens, so the effects of the Sun's energy in developing the region's climate, weather and winds enters naturally. Examples abound and discussions can be extended and sophistication adapted to the different grade levels.

What about the teacher ? First, it should be a more interesting and challenging program than excluding or limiting science at the earlier grades. Second, the lesson plan requires only a small amount of science at one time, which should make it more conducive to learning and instruction. In addition, it lends itself to team teaching where both the pupils and teachers can learn. The advantages of the "unified field" model is that it is flexible, can be broadened or limited in extent, can be adapted to special interest such as documentaries on public TV, or museum exhibits, etc., it displays science as an active force in our lives, it helps to break down the barriers between teachers of different disciplines and also eases problems derived from of out-of-discipline teachers.

There is one final point which derives from my study of ninth grade high school students. Many teachers say that the non-motivated types generally enjoy doing something active such as drawing or building models. In addition, they all seek recognition for the, unfortunately too little, work many do. A program in which they can contribute to, which instructs at the same time in a socializing way appears to be an attractive alternative that might work in today's "class rooms in conflict". The integration of subjects to a greater degree than at present makes education more efficient which would also mean more interesting to students.

USING LITERATURE TO UNDERSTAND AIDS

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The HIV virus, cause of AIDS, may have infected as many as five million persons worldwide, perhaps one and half million of those in the United States. Many American teenagers however still refuse to take it seriously. According to statistics from the Centers for Disease Control (CDC), cases of AIDS among 13-to-19 year olds went up 43 percent between July 1988 and July 1989, with the use of crack considered one of the causes. Because crack is not injected, many young people do not understand that it is one of the risky behaviors which can lead to AIDS in that it impairs judgment about whom to have sex with and how. At the Fifth International Conference on AIDS in June 1989, June Machover Reinisch, Executive Director of the Indiana University Kinsey Institute for Research in Sex, Gender, and Reproduction, reported the findings of a study done at a large, conservative Midwestern university on the sexual experiences of white, male, middle-class students. They were not only not using condoms, but had the strange belief that using them once a year granted long-term protection (Goldstein, 1989, p. 13). According to another study in the December 1989 issue of Pediatrics, conducted jointly by the University of Oklahoma and Texas Tech University of 448 adolescents, AIDS education increased students' understanding of persons with AIDS (PWAs) and improved their basic knowledge about the disease. However, it did little to alter their behavior when it came to taking personal risks, with very few practicing the recommended prevention procedures (Knox, 1989, p. 3). Though 2.5 million teen-agers contract a venereal disease every year and 800,000 become pregnant, less than 4 percent protect themselves with condoms ("Shouts," 1989). Why are they willing to risk their lives in this way and how can we as educators get through to them with the essential message that AIDS kills?

To tackle first the reasons for their risky behavior, the enormity of teenage hubris is common knowledge--they simply do not believe in their own vulnerability. Modern technology, as Martin Heidegger has pointed out in his essay "On the Question of Technology," with its ongoing production of miracles, contributes greatly to this sense of personal immortality. Just read the sensational articles which attack us at every checkout counter. Pills at your local drug store will cure everything. Liz Taylor and Michael Jackson through the help of technology are going to live forever. Why shouldn't the hubris of today's young people be reinforced, along with the belief that even AIDS can be defeated by modern technology?

Another reason why young people are not getting the AIDS message is that they are receiving very mixed messages about sex in general from the culture as a whole. Three 1988 studies from the Alan Guttmacher Institute suggest that when it comes to attitudes about sex, America is a backward country. Sexual activity among single women between 15 to 44 continues to increase: 68% in 1982; 76% in 1988. Within this group, the pregnancy rates for single women in their teens and twenties are extremely high, with Greece and Ireland the only two countries in the study having higher rates, and with only Italy having a higher abortion rate. One of the reasons cited is poor access to the wide range of contraceptives available in most of the countries studied. Another reason is that information about contraceptive methods and services is inconsistent ("Shouts," 1988).

The government, experts, organized religion and parents send out very mixed messages to young people. President Reagan refused to mention AIDS until very late in the epidemic, whereas former Admiral Watkins who headed up the National AIDS Commission called for an all-out war on the disease, and Surgeon General Koop sent out a very explicit pamphlet "Understanding AIDS" to every mailing address in the United States. Conservatives delayed a proposed Public Health Service national survey of sexual behavior intended to help fight AIDS, and continue to attack the NEA for funding explicit works of art dealing with AIDS, seen in the controversies over Andres Serrano's "Piss Christ," the Corcoran's Robert Mapplethorpe exhibit, and the New York gallery exhibit "Witnesses: to Our Vanishing." But the National AIDS Program Office set up a hot-line in May 1989 to answer questions about the latest drug research. Conservative William J. Bennett, when he was Secretary of Education, distributed in late 1987 a pamphlet designed for parents and teachers "AIDS and the Education of Our Children," which emphasized the need for abstinence. Early in 1988, the CDC also sent out a 14-page booklet to help school systems plan their own AIDS education programs which advocated teaching about the need to use condoms and clean needles. In Massachusetts, with 2,489 cases as of December 1989, as early as April 1986, the Public Health Department began issuing AIDS Fact Sheets, and today my small Sudbury library regularly posts AIDS information with a hotline number. In nearby New Hampshire in May 1989, with 104 reported AIDS cases and as many as 600 predicted by 1992, the state was planning to begin its first public education campaign in July.

Young people get very mixed messages from the media which publicizes the latest research and findings by experts, often suggesting that a miracle cure is very near at hand. Masters and Johnson's book, Crisis: Heterosexual Behavior in the Age of AIDS, (1988) claimed that as many as 3 million Americans were infected with HIV and that heterosexual AIDS was exploding. It got enormous media publicity even though most experts considered many of their findings inaccurate and dangerously misleading.

Organized religion is radically divided about how to respond to the AIDS crisis. While liberal clerics are urging compassion and an all out effort to combat the ignorance and prejudice surrounding AIDS, some bastions of fundamentalism are claiming that AIDS is God's punishment for sin. The American Council of Christian Churches, a fundamentalist group who say they represent two million "Bible Christians," are on record that AIDS is God's punishment for homosexuals and drug addicts (Steinfels, 1989).

Complaint by Catholic clergy was voiced at a Vatican conference on AIDS in November 1989 that the Church was not listening to PWAs themselves and focusing all its attention on sexual behavior and drug use ("Bishops," 1989, p. 3). In October 1989, the American Catholic Bishops' Ad Hoc Committee on the HIV Virus forbade teaching about condoms. Its chairman, Archbishop Roger Mahony of Los Angeles, said: "There is no such thing as safe, or safer, sex. That's an illusion" (AP, 1989, 13 Oct.). This edict stemmed from an earlier pronouncement on December 10, 1987, in a 30-page church policy paper saying that it is sometimes appropriate to teach that condoms can prevent AIDS because some "people will not act as they can and should." But conservative forces within the Church, led by New York's John Cardinal O'Connor strongly rejected this teaching, leading to the later pronouncement forbiding it.

In the home, even with the threat of AIDS, many parents are still reluctant for a variety of reasons to talk openly with their teenagers about sex. All of this places a tremendous burden on the nation's education system to teach young people about AIDS. Pleas for more open sex education are increasing. As of July 1989, only six states openly discussed use of condoms (Mitgang, 1989). To help on college campuses, manufacturers have donated thousand of free condoms annually (Shearer, 1990). When my daughter was at the University of Wisconsin-Madison, she was notified at the beginning of 1988 by the University News Service that two medical ethics professors were offering a course open to the general public on the ethical and social issues of AIDS. Many towns near me began including a written curriculum on AIDS in the 1988-89 academic year. These include such affluent Massachusetts communities as Wayland, Weston, Wellesley and Newton. Sudbury, where I live, another affluent bedroom community west of Boston, began its AIDS education in Kindergarten through Grade 8 early in 1988. The predominantly working-class community of Watertown was selected in 1987 by the Red Cross along with six other school systems in the country to study an AIDS curriculum for grades 7-12. Part of the program used a film titled "A Letter from Brian," which tells of a 17-year-old girl who receives a letter from an old boyfriend who has contracted AIDS and decides she will not become sexually involved with a new boyfriend. Another film used by the program is "Beyond Fear," which explores facts and myths surrounding AIDS.

All of these were incorporated without controversy, but when Boston made similar plans, Cardinal Law spoke out strongly against them. Students in grades 6 through 12 were to receive two 45-minute lessons stressing abstinence from sex and avoidance of IV drug use. The lessons however also include instructions of how to use condoms. This is what Cardinal Law vehemently objected to, labeling such teaching "valueless" and "amoral." Such a curriculum "admits of a permissiveness in sexual behavior which is not acceptable to a great many citizens of the city, is certainly unacceptable for Catholics, and which increases the children's risk of getting AIDS" (Franklin & Dumanoski, 1989). The Cardinal offered his own program instead which would stress morals, integrate sex education into daily instruction, and use retreats and discussion for older students to share their experiences and questions. The program, Rev. Michael Steele, director of religious education for the Boston archdiocese, insisted, could handle problems of youthful sexuality, including AIDS (Franklin, 1989).

Controversy among authorities and reluctance of parents to talk openly about sexual matters can contribute to the unwillingness of young adults to think seriously about the consequences of risky sexual behavior. How can literature hope to open their eyes about how such behavior can lead to AIDS? Aristotle said it long ago; poetry is truer than history because it illustrates realities which mere facts can only gloss. And it is more moving than abstract ethical discussion no matter how profound because the human mind cannot totally grasp generalizations without concrete examples. If you do not believe me, try reading some recent literary criticism. It is my contention that courses which use literature to teach young people about AIDS, if designed properly, can be more effective than sessions which merely preach to them and bombard them with the horrifying statistics.

Although Susan Sontag in AIDS as Metaphor inveighs against using the plague trope to discuss AIDS, it can be helpful to show how ignorance leads people to superstitions and scapegoating. Studying Sophocles' tragedy Oedipus provides a good basis for this kind of discussion. In A Distant Mirror (1978), Barbara Tuchman has an excellent chapter on the mid-fourteenth century's Black Death, which along with showing Ingmar Bergman's famous film The Seventh Seal (1957) can give students some sense of how people responded in medieval times. Samuel Pepys' Diary (1 Jan. 1660-31 May 1669) describes the Great Plague of London which occurred in 1664-5. Daniel Defoe purports to narrate an account of this same plague in his fictitious A Journal of a Plague Year (1722), but it was actually prompted by an outbreak of plague in 1721 in Marseilles. Defoe probably used another plague account as his source--Thomas Dekker's 1603 pamphlet The Wonderfull Yeare which described the awful conditions in London that year from the plague. As with any work by Defoe, the Journal is loaded with seemingly factual details giving it sharp authenticity. Camus' 1948 novel The Plague (La Peste, 1947) offers ample opportunities for philosophic discussion, with its dramatization not only of a fictional modern plague in a large Algerian city, but of Camus' analysis of the "absurdity" of the human condition. Camus also depicts how reluctant people are to admit anything is wrong and the tendency to scapegoat once they do. Use of the plague trope also permits the intructor to explain that, unlike the plague, tuberculosis, typhoid, cholera and others, AIDS is not a highly infectious disease; that it can only be contracted through unprotected sexual intercourse or contact with blood which contains the HIV virus. This is good for refuting stories about saliva, mosquitoes, careless cafeteria workers, which have produced hysterical reactions--burning the home of two hemophiliac boys in Florida, for example, because they wanted to go to school.

A good novel to address this overall fear of AIDS is Alice Hoffman's At Risk (Putnams, 1988), about an 11-year-old eighth-grade girl, Amanda Farrell, who contracts AIDS from a blood transfusion she had during an appendix operation five years before. As local parents learn of her condition, they put pressure on the school principal to remove her from classes. At school, the little girls are afraid to use the toilets and think you can get AIDS from kissing. No one will sit next to her younger brother, and his best friend, the only person in the world he can stand, is forbidden from seeing him. This takes place in an affluent Massachusetts North Shore community. If Amanda were dying from anything else, neighbors would be rushing over with casseroles and condolences. But because it is AIDS, the family is shunned as though they were lepers. The pressure of Amanda's imminent death threatens to destroy the entire family as each seeks someone outside for comfort. They go through all the stages of grief outlined by Elizabeth Kubler-Ross in her books on the subject, and specifically in AIDS: The Ultimate Challenge (MacMillan, 1987).

A moving autobiograhical work I have used to depict the suffering of loved ones, as well as the harrowing stages of AIDS illness, is Barbara Peabody's The Screaming Room: A Mother's Journal of Her Son's Struggle with AIDS (Avon, 1986).

Another appropriate work is by the popular author M. E. Kerr, whose novels for young adults win high praise. Her Night Kites (Harper & Row, 1986) tells how a teenager handles AIDS in the older brother he has always adored. Using the language and concerns of today's youth--friendship, adult disapproval, sex, rock music--Ms. Kerr's work is good AIDS fiction for young adults. Besides Hoffman's At Risk, another novel about a young person with transfusion AIDS is Good-bye Tomorrow (Dell, 1987) by Gloria Miklowitz who also writes novels for teenagers. In it, she examines the social ostracism a high school boy encounters from his former classmates. Another much more sophisticated work, but still immersed in teen concerns and language, is nineteen-year-old Californian Holly Uyemoto's witty first novel Rebel Without a Clue (Crown 1989). It is told in "valley-talk" style by a likeable but confused adolescent boy Christian whose best friend, a gorgeous male model, has contracted AIDS.

This novel serves as a good transition to two plays about gay AIDS and two Before/After accounts of gay sex. Larry Kramer's moving drama The Normal Heart, first performed April 21, 1985 (New American Library, 1985) inveigns against the government's neglect of AIDS in its early stages and shows how gay men had to organize politically to help one another. William Hoffman's As Is (Vintage/Random House, 1985) was, I believe, the first AIDS drama. Its realistically sad portrayal is very moving, though some details in it are outdated. The latter, incidentally, is an ongoing problem, since new research changes the realities of AIDS almost daily. Still the human truths this literature depicts give it lasting value.

Two Before/After novels about gay life are both first novels: David B. Feinberg's *Eighty-Sixed* (Viking, 1989) and Joel Redon's *Bloodstream* (Knights Press, Stamford, Ct., 1989). They form a good contrast: Redon's mood is serious and deeply committed to learning to live with AIDS with dignity; Feinberg's mood on the other hand is ironic, almost flippant, as he shows how different gay sex in 1986 is from the heady days of 1980. Another work which employs humor to cope with this tragedy in young lives is *Tweeds* (Knights, 1987) by Clayton R. Graham (pseudonym of Larry Ebemeier). In a comic *bildungsroman* (education novel) format, a short, pudgy librarian Corey Reese goes to Chicago where he meets his childhood love Scott Sommerfeld only to learn that Scott, now a handsome actor, has AIDS.

To give students a sense of the tragedy's full scope, Randy Shilts'superb work of journalism *And the Band Played On* (St. Martin's, 1987) reads in parts like a medical thriller with good guys and bad guys both defeated by the implacable virus while an indifferent establishment turns its back. Shilts is long with too much detail about the bathhouse-closing controversy, but with some omissions, it is still in my opinion the most powerful piece of AIDS literature produced thus far.

To date, I know of no good literary work about minority AIDS and would welcome any information about one. Warnings about AIDS have appeared in the popular Rap music. The group Fat Boys did a song called "Protect Yourself" on their album *Crushin'* (Polydor 1987). Jamaican-born, Bronx-bred Shelly Thunder does "Greatest Adviser," which pleads for safe sex and against crack. Even one of the "meaner" ("mad as hell"; loaded with obscenity) rap singers Big Daddy Kane in "Ain't No Stopping Us Now" warns against drugs and pushes education (Milano, 1990). In Boston, a local group of mostly high school students calling themselves the Positive Force Posse, have made a tape called "It's not who you are, It's what you do" which uses rap together with educational materials to teach urban youth about AIDS. Employing the driving rhythms young people love, the group tells of the dangers of unprotected sex and unclean needles.

> It's not who you are, It's what you do; Kids could be infected and so could you . . . And check this selection would you risk infection for an IV injection. Think about it and don't be dumb without a condom. . . . Don't ever take a chance, not a single one because it make no sense dying after fun. . . . In the distance there's a chance, there's hope for romance. Please listen to the facts, not the myths. Casual contact is not a risk. Hey baby, a kiss is still a kiss (Ribadeneira 1990, 26).

Allan Bloom et al. may long for a return to the classics of western civilization and bemoan the influence of rock music with its pleasing sensuality and mindless repetitions. Bloom's beloved Plato would have evicted poets and musicians from his Republic. But like it or not, television, particularly MTV and popular music, are perhaps today's most potent teachers of the young. They may be where we have to turn for much AIDS education in the future.

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THE IOWA CHAUTAUQUA PROGRAM:
WHAT ASSESSMENT RESULTS INDICATE ABOUT STS INSTRUCTION

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The Iowa Chautauqua Program was developed in 1983 with support from national Chautauqua funds from NSF which were awarded to NSTA to study an inexpensive in-service model for stimulating reform in K-12 science classrooms. In Iowa the Chautauqua effort has focused upon STS materials and strategies with primary attention directed to teachers in grades 4 through 9. The program began with 30 teachers enrolled in a program in one center and expanded to 230 teachers enrolled in five centers across the state during the 1989-90 year. To date 1,500 teachers have been enrolled during the 1983-90 interim.

After the initial year the Iowa Utility Association (IUA) sought-out the project for additional support. During the three years of the NSF grant to NSTA, the IUA support was three times greater. After three years the NSTA Chautauqua Program was terminated. However, NSF support has continued with a grant to The University of Iowa. Further, three EESA summer grants have also supported the Iowa program. An outline of the Iowa Chautauqua In-Service model is included as Figure 1. STS in Iowa is defined as materials and strategies teachers devise as a new context for their existing programs. To be considered STS the materials developed must have ten basic features. These include:

1. the identification of problems with local interest and impact;
2. the use of local resources (human and material) to locate information that can be used in problem resolution;
3. the active involvement of students in seeking information that can be applied to solve real-life problems;
4. the extension of learning going beyond the class period, the classroom, the school;
5. a focus upon the impact on science on each individual student;
6. a view that science content is not something that exists for students to master on tests;
7. a de-emphasis upon process skills *per se* just because they represent glamorized skills of practicing scientists;
8. an emphasis upon career awareness--especially careers related to science and technology;
9. opportunities for students to perform in citizenship roles as they attempt to resolve issues they have identified;
10. identification of ways that science and technology are likely to impact the future.

A major component in the Iowa Chautauqua Program is assessment. One aspect of the assessment effort is the effect of STS on students. Five domains of science education proposed by Yager and McCormack (1989) are used to assess student growth by the use of pre and post assessment instruments in each domain.

Experienced STS teachers are major parts of the instructional team in the Iowa Chautauqua Program. These are the teachers who were most enthused with their own STS initiatives, who spend the most time in their courses with STS, who were anxious to complete assessment projects, and who were willing to be a part of the annual leadership conferences.

As one might expect, some of the most exciting assessment results are provided by the most successful STS teachers. As assessment instruments were developed, twelve lead teachers volunteered to help. Figures 2-6 are graphs of the results of assessment in the five domains with twelve teachers with 24 sections of students, 365 students in STS sections and 359 students in traditional sections.

Figure 1

IOWA CHAUTAUQUA MODEL

*** LEADERSHIP CONFERENCE **

A Week Long Conference Designed To

1. Prepare staff team for conducting workshop series which follows for 30 new teachers.
    - a) One lead teacher per ten new teachers
    - b) Scientists from a variety of disciplines
    - c) Scientists from industry
    - d) Administrators
    - e) Science Supervisors/Coordinators as chair of staff teams
2. Organization and scheduling for each workshop
3. Publicity and reporting
4. Assessment Strategies
    - a) Five domains
    - b) Use of reports
    - c) New research plans for Lead Teachers

*** TWO WEEK SUMMER WORKSHOP ***

An STS Experience

1. Includes special activities and field experiences that relate specific content within the disciplines of biology, chemistry, earth science, and physics.
2. Makes connections between science, technology, society within the context of real world issues.
3. Issues such as air quality, water quality, land use/management are used as the context for concept development.

*** ACADEMIC YEAR WORKSHOP SERIES ***

Fall Short Course

Awareness Workshop

20 hr Instructional Block
(Thursday pm, Friday,
& Saturday)

Activities include:

1. Review problems with traditional view of science and science teaching
2. Outline essence of STS
3. Define techniques for developing STS modules and assessing their effectiveness
4. Select a tentative module topic
5. Practice with specific assessment tools in each STS Domain

------>

Interim Project

Three Month Interim Project

The STS Module
1. Developing instructional plan for minimum of twenty days
2. Administer pretests in five domains
3. Teach STS module
4. Collect posttest information
5. Communicate with regional staff, Lead Teachers, and central Chautauqua staff

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Spring Short Course

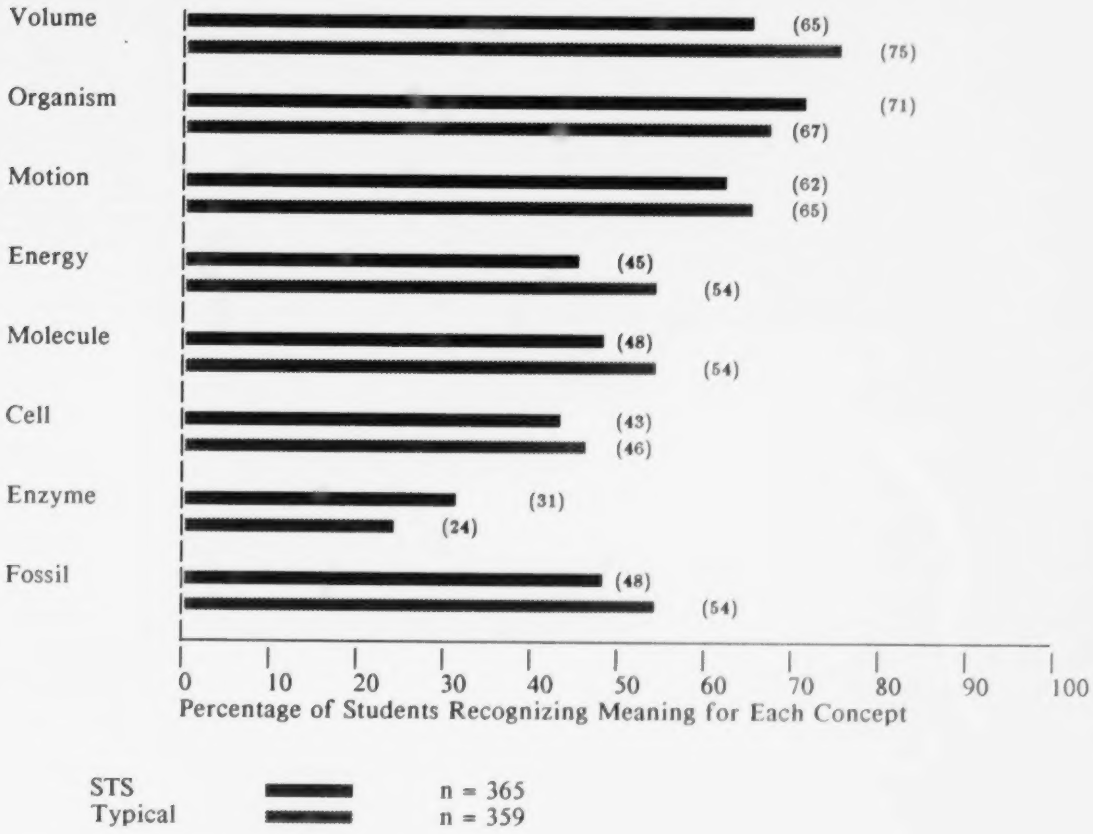
Final Workshop

20 hr Instructional Block
for Thursday pm, Friday,
& Saturday)

Activities include:

1. Report on STS experiences
2. Report on assessment efforts
3. Interact on new information concerning STS
4. Plan for involvement in professional meetings
5. Plan for next-step STS initiatives

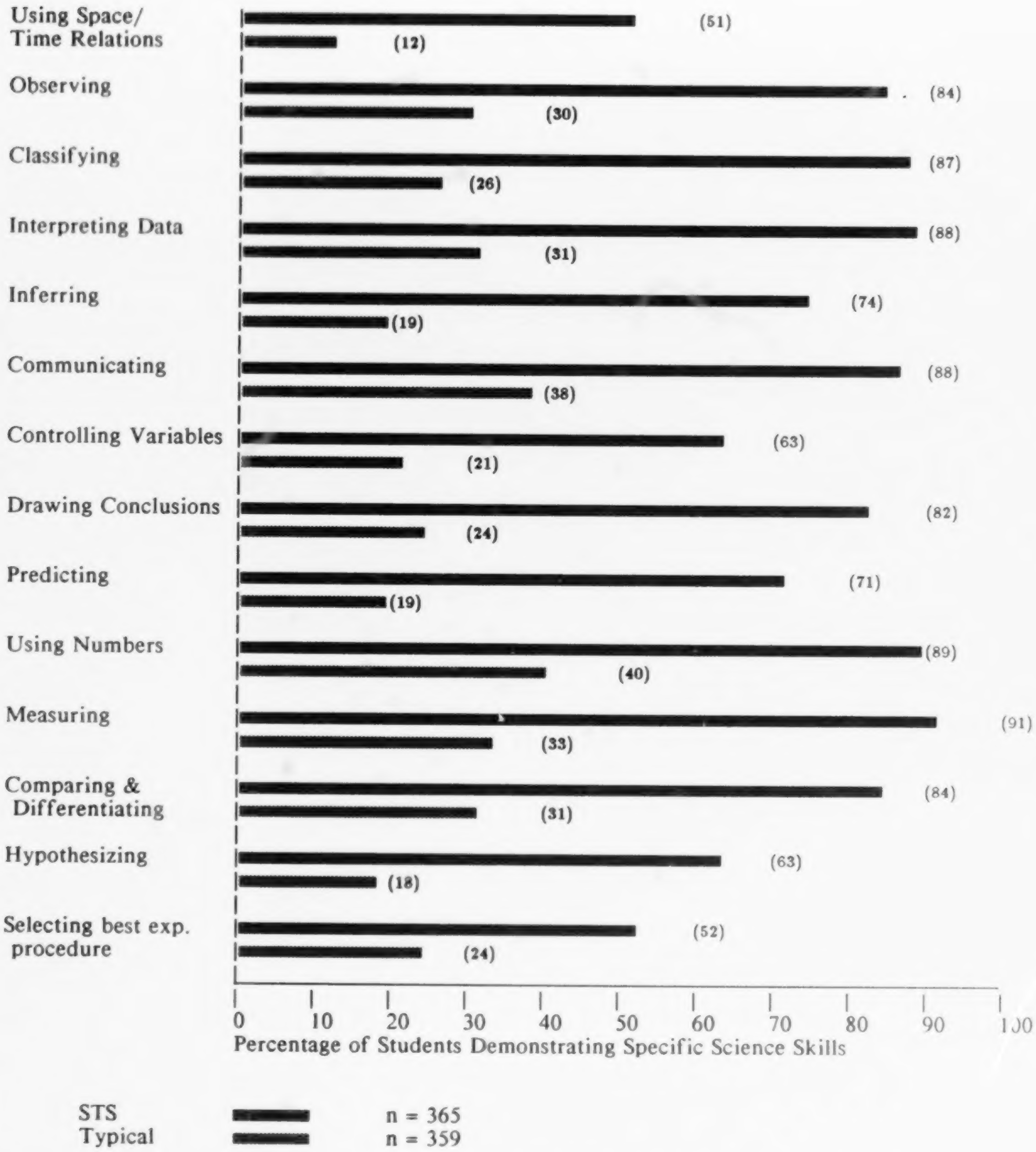
Figure 2
Student Ability to Recognize Definitions
of Eight Basic Science Concepts



Note: None of the differences are statically significant

Figure 3

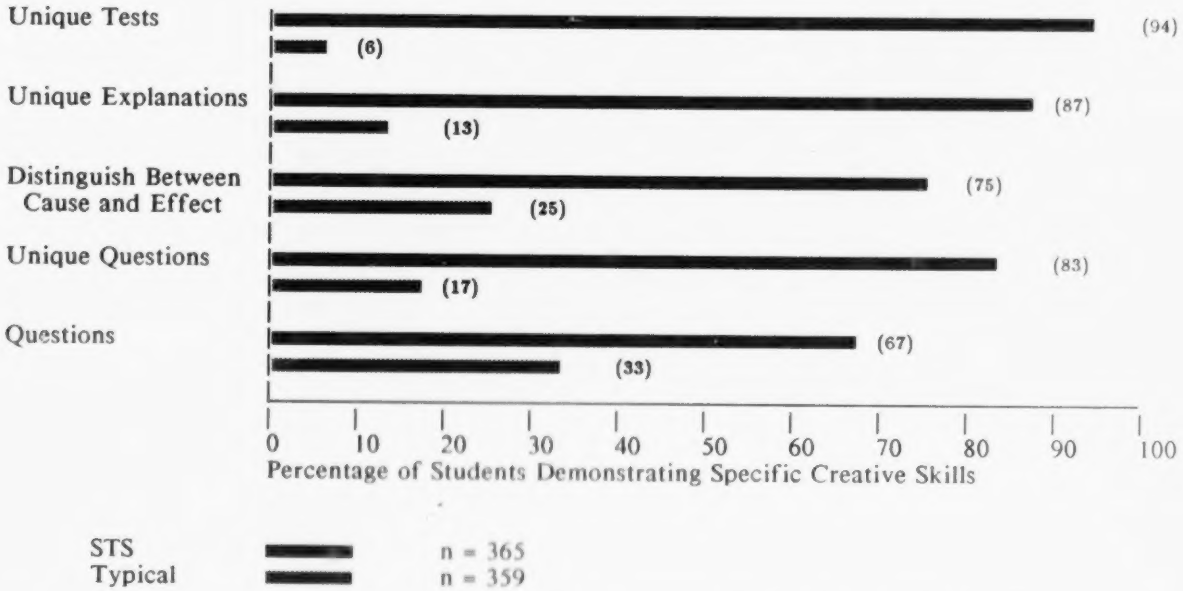
Student Ability to Utilize Process Skills



Note: All differences in favor of STS instruction are statistically significant (0.01 level).

Figure 4

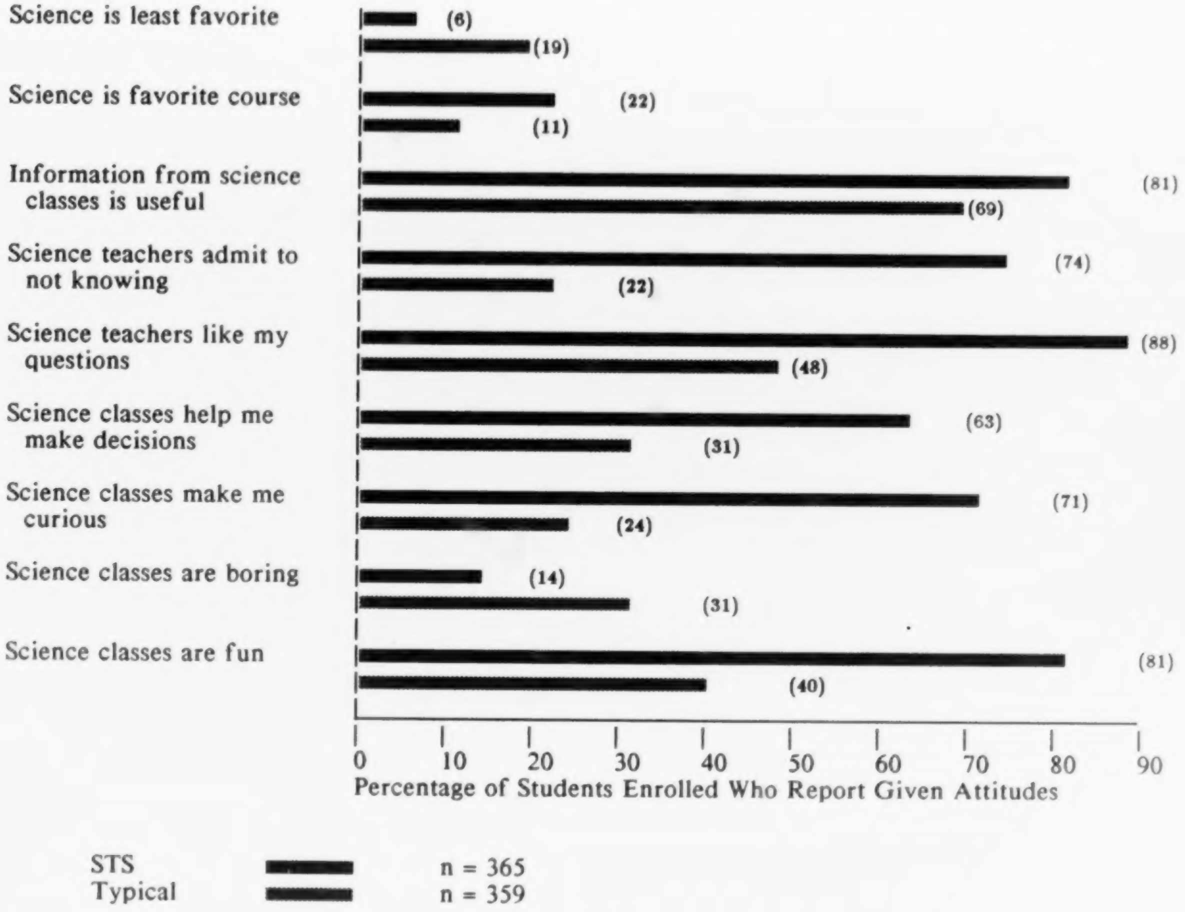
A Measure of Creative Thinking



Note: All differences in favor of STS instruction are statistically significant (0.01 level).

Figure 5

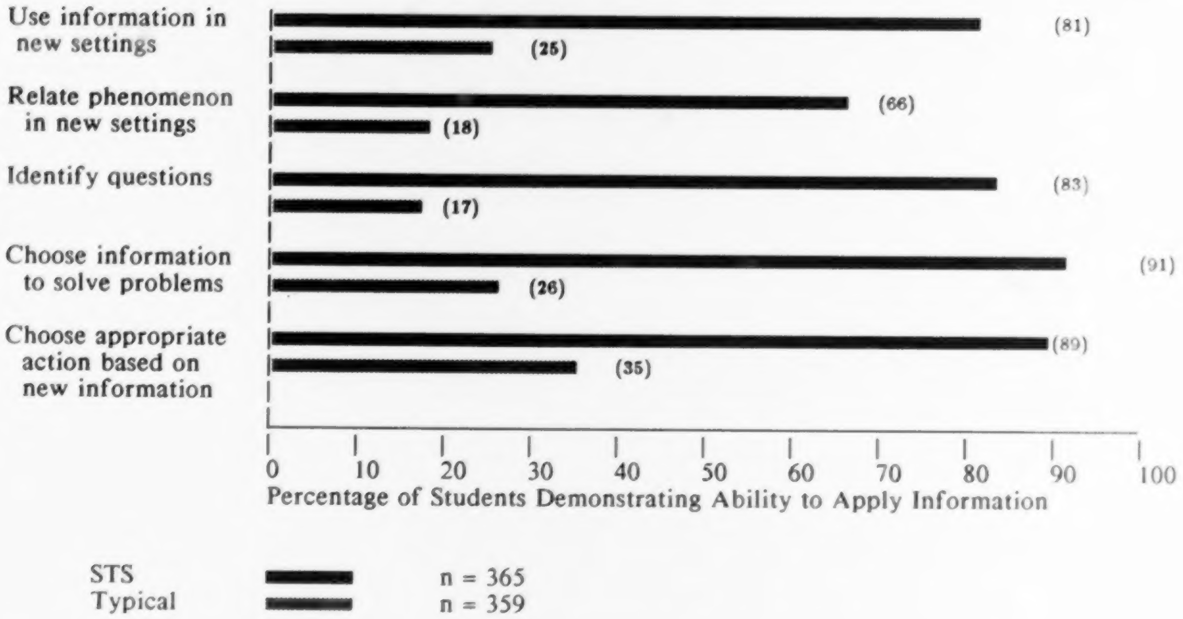
Student Attitude About Science Instruction



Note: All differences in favor of STS instruction are statistically significant (0.01 level).

Figure 6

Student Ability to Apply Information



Note: All differences in favor of STS instruction are statistically significant (0.01 level).

All twelve lead teachers in grades 6 through 8 were interested in the degree of master of concepts and student ability to use them. Some were especially interested in stimulating and measuring growth with respect to process; others were more interested in the development of creativity skills; others were concerned with student attitudes.

When teachers express interest in such areas and expect students to grow, exciting results emerge. Teacher ownership and their expectations of student achievement may be more important than an STS format and/or the exclusive focus on typical topics. Nonetheless, the Iowa Chautauqua program permits the following observations based upon assessment of students taught by lead teachers who taught at least two sections to contrast in STS and non-STS sections. It is important, however, to emphasize the teacher belief that student growth in the particular domain was important and possible. The contrasts include:

1) STS students achieve just as well as students enrolled in a more typical courses. In about 25 percent of the classrooms students out perform non-STS students at the 0.05 level of confidence.
2) STS students outperform non-STS students in their mastery of process skills by two times (on all 13 of the S-APA processes).
3) Attitude is three times better for STS students than non-STS students.
4) Student creativity as observed in terms of quantity of questions generated, predictions of certain consequences, and ideas about possible causes for given phenomenon are increased by a factor of two in favor of STS students.
5) Student creativity in terms of quality/uniqueness of questions, prediction of consequences, and ideas about possible causes are six times greater for STS students than non-STS students.
6) The ability of students to utilize information and processes in new situations is three to four times greater for STS students than non-STS students.

More evidence, more ideas, and higher expectations regarding student growth as a result of STS efforts in K-12 science classrooms are needed. Admittedly the results from students in schools taught by experienced STS teachers -- and staff members in the Iowa Chautauqua Program -- are not drawn from a random sample of teachers nor an unbiased group concerning the power and value of STS. However, analyses of results in each domain have been conducted with the most successful first-time STS teachers as well. Following are some results from such efforts.

The Muscatine Experience (Larry Myers)

Six teachers from grades 8 and 9 were involved in the study as each identified students enrolled in an STS section and a textbook section. Tables 1 and 2 indicate pre- and posttest results in the concept domain.

Table 1
Mean and Standard Deviation for the Traditional and STS Groups
on Pretest and Posttest Scores in the Concept Domain

	Pretest		Posttest	
	Traditional	STS	Traditional	STS
Teachers	6	6	6	6
Students	154	203	154	203
Mean	17.83	17.50	35.17	36.83
Standard Deviation	4.71	3.62	7.96	5.42

Table 2
Results of the t-test Analyses for the Concept Domain

Purpose of t-test	**Results**	**Conclusion**
To check if the average pretest scores is equal to the average posttest score for the traditional group	t = 4.591 DF = 10.000 PROB = 0.001	For the traditional group, the average pretest score is significantly different than the average posttest score.
To check if the average pretest score is equal to the average posttest score for the STS group	t = 7.267 DF = 10.000 PROB = 0.000	For the STS group, the average pretest score is significantly different than the average posttest score.
To check if the average score on the pretest is not different for the two groups	t = 0.137 DF = 10.000 PROB = 0.893	The traditional and STS groups do not have different pretest scores.
To check if the average score on the posttest is not different for the two groups	t = 0.424 DF = 10.000 PROB = 0.681	The traditional and STS groups do not have different posttest scores.

It can be seen from Tables 3 and 4 that STS and traditional approaches to science instruction result in no statistically better ways of stimulating student growth in mastery of concepts. Perhaps it is most noteworthy that students who experience their science as STS are as successful as those who experience science as a direct mastery of concepts identified in advance of instruction.

Eight teachers from grades 8 and 9 were involved with a similar study in the applications domain. Tables 3 and 4 indicated the results with an analysis of pre and posttest results.

Table 3
Mean and Standard Deviation for the Traditional and STS Groups
on Pretest and Posttest Scores in the Applications Domain

	Pretest		Posttest	
	Traditional	STS	Traditional	STS
Teachers	8	8	8	8
Students	203	203	197	197
Mean	20.88	19.38	25.25	39.12
Standard Deviation	5.99	4.56	5.99	7.16

Table 4
Results of the t-test Analyses for the Applications Domain

Purpose of t-test	**Results**	**Conclusion**
To check if the average pretest scores is equal to the average posttest score for the traditional group	t = 1.46 DF = 14.00 PROB = 0.166	For the traditional group, the average pretest score is not significantly different than the average posttest score.

To check if the average pretest score is equal to the average posttest score for the STS group	t = 6.578 DF = 14.000 PROB = 0.000	For the STS group, the average pretest score is significantly different than the average posttest score.
To check if the average score on the pretest is not different for the two groups	t = 0.564 DF = 14.000 PROB = 0.582	The traditional and STS groups do not have different pretest scores.
To check if the average score on the posttest is not different for the two groups	t = 0.203 DF = 14.000 PROB = 0.001	The traditional and STS groups have significantly different posttest scores.

The results indicate that the STS students are far more successful in illustrating their ability to apply concepts in new situations. The students in the traditional classrooms did not improve at all in their ability to apply concepts. On the other hand STS students significantly grew in their ability to apply their knowledge (.001 level of confidence) over students who study science directly from typical textbooks.

The Grinnell Experience (Susan Blunck)

Creativity skills as defined by Torrance (1966) are closer to the definition of science that George Gaylord Simpson offered:

> Science is an exploration of the material universe that seeks natural, orderly relationships among observed phenomena and that is self-testing (Simpson, 1963, p. 82).

These skills include frequency and uniqueness of questions, causes, and consequences concerning the report of certain discrepant events. Table 5 displays the results of student growth in demonstrated creativity skills prior to and following STS instruction and compares them to results when students experience their science in more traditional ways.

Table 5

Significance of Growth Between Pre-and Posttests for Features of Creativity in Concept-Oriented Classes Compared to Issue/Question-Oriented Classes

A. Comparison of Pre vs Posttest Scores with Concept Oriented Sections

		Pretest Mean	S.D.	Posttest Mean	S.D.	t-Value
1)	Questions	15.03	3.82	15.80	3.63	0.51
2)	Unique Questions	3.24	0.73	3.53	0.88	0.88
3)	Causes	12.15	1.97	12.77	2.04	0.75
4)	Unique Causes	2.48	0.63	2.68	0.87	0.65
5)	Consequences	12.57	2.10	12.82	2.38	0.27
6)	Unique Consequences	2.41	0.45	2.43	0.47	0.09

B. Comparison of Pre vs Posttest Scores with Issue/Question-Oriented Section

		Pretest Mean	S.D.	Posttest Mean	S.D.	t-Value
1)	Questions	15.34	4.00	31.68	7.43	6.71*
2)	Unique Questions	3.23	0.80	19.92	4.30	13.21*
3)	Causes	11.33	2.67	22.68	4.10	8.39*
4)	Unique Causes	2.16	0.56	12.58	3.50	10.18*
5)	Consequences	12.30	2.43	25.52	4.08	9.65*
6)	Unique Consequences	2.27	0.64	13.60	2.80	13.65*

C. Comparison of Posttest Scores for Concept-Oriented Section vs Question/Issue-Oriented Section

		Posttest Concept Oriented Mean	S.D.	Posttest Question/ Issue Mean	S.D.	t-Value
1)	Questions	15.80	3.63	31.68	7.43	6.65*
2)	Unique Questions	3.53	0.88	12.92	4.30	12.93*
3)	Causes	12.77	2.04	22.68	4.10	7.50*
4)	Unique Causes	2.68	0.87	12.58	3.50	9.51*
5)	Consequences	12.82	0.38	25.52	4.08	9.32*
6)	Unique Consequences	2.43	0.47	13.60	2.80	13.62*

* indicates significance ($p < 0.001$)
STS n = 326
Traditional n = 314

Table 6 displays the results contrasting student growth in the process domain with a similar study involving STS and traditional class sections. It can be seen that students in the STS sections grew significantly in terms of their ability to operate selected science process skills. Students in the traditional sections did not increase in their ability to recognize and to use such skills.

STS materials and strategies enhance student skills with the processes of science as well as basic creativity skills, including questioning, suggesting causes, and predicting consequences. Certainly these skill areas are related and may overlap. However, a value of STS seems to be a marked enhancement of student growth in these two domains.

Table 6
Changes in Pre - Posttest Results on Science Process Skills
For Students in Grades 4-9 in STS and Traditional Sections

	Traditional			STS		
Grade	Pretest Mean	Posttest Mean	t-value	Pretest Mean	Posttest Mean	t-value
4	2.65	2.6	0.1	2.70	4.68	7.21*
5	3.41	3.39	0.0	3.75	5.3	7.21*
6	5.10	5.05	0.0	5.06	6.84	7.22*
7	4.12	4.11	0.0	4.02	5.30	6.77*
8	5.00	5.11	0.0	4.97	6.51	6.78*
9	5.81	5.91	0.0	5.77	7.73	6.79*

* indicates significance at 0.01 level
STS n = 59
Traditional n = 54

The 1988-89 Sample of 176 Iowa Teachers (Bill McComas)

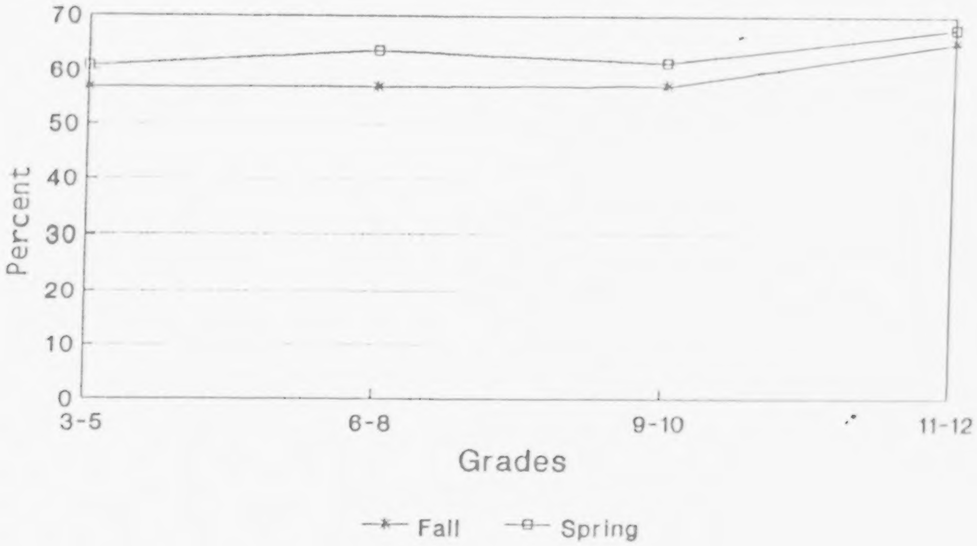
Many educators have advanced justifications for the measurement of attitudes within science class, but perhaps Schwab and Brandwein (1962) said it best when they suggested that for students to maintain and support scientific inquiry *outside* of school it is necessary that they develop favorable attitudes toward all aspects of science while *in* school.

One of the major problem areas in relationship to attitudes is that, in general, there is declining interest in science expressed by students themselves following participation in science classes (Lawrenz, 1976). This observation was supported by the National Assessment of Educational Progress (NAEP, 1978) and by the follow-up study done by Yager and Penick (1986). In the newest NAEP summary, Mullis and Jenkins (1986), state that "most students in the third, seventh, and eleventh grades appear to be unenthusiastic about the value and personal relevance of their science learning and their attitudes seem to decline as they progress through school," and that "less than half of seventh graders - and even fewer eleventh graders - perceived science would help them to earn a living, be important to them in life, or be used in many ways during adulthood." In short, it seems that the longer students study science, the less they like it. Needless to say indications such as these are discouraging.

The instrument developed for use in the Chautauqua workshops, modified from that used during the NAEP study, has as its central objective the assessment of student perceptions of their science classes, science teachers, and the value of science study. The instrument consisted of approximately fifty items with the choice of "Yes," "No," and "I Don't Know" provided for questions which appear in a form such as, *"Does your teacher enjoy science?"*

One of the most exciting results from this study may be seen in Figure 7 which provides a grade-by-grade analysis of the question, *"Is science generally useful?"* These data provide indications that those students exposed to the STS philosophy find science more worthwhile at these higher grade levels. While this study is preliminary, the results stand in direct contrast to the earlier projects which show increasingly negative attitudes the longer students study science.

Figure 7
Grouped Data Showing Affirmative Student Perceptions Regarding the General Usefulness of Science



The items which showed significant change are detailed in Table 7. These data indicate that students seemed increasingly more positive when asked questions about the usefulness of science information outside of school, the applicability to science class to future careers, the place of technology in daily living and basic feelings about their experiences with school science.

In the category of student perceptions of the value of studying science we see that students find science information increasingly more useful outside of school, useful for further study, and helpful with careers than they did before the introduction of STS. At the same time, students feel that science class is exciting and fun. Students also agree that technology affects daily living; the change in this perception clearly illustrates that the technology aspect of STS has been communicated well.

STS units of instruction resulted in changes in the way students perceive their teacher, and perhaps in the way in which teachers themselves perform. As found in an earlier study, the biggest change is in the area of whether students felt teachers admitted to knowing all the answers to questions. It is clear that STS teachers have successfully communicated the idea that they *cannot*, and should not, be considered the sole source for all information in their students' lives. Approximately 60 percent of the students perceived that their teachers admit to not knowing answers to all student questions before the introduction of the STS unit, but after the issue-based module of instruction, 71 percent of students felt that teachers did not know all the answers. When teachers adopt the philosophy that issues, not just correct answers, are the real concern, this is no surprise. Clearly, an issue-based teaching philosophy can make real changes in the neglected area of student attitudes. Tables 7, 8, and 9 indicated percent of affirmative student responses across grade levels 1 and 3-12 which show significant changes from pretest to posttest. On average, 1735 students responded to each question.

Table 7

Student Opinions About Science Itself When in STS Classes

	Pretest	Posttest	Change	Chi-Square
Science is Useful:				
In Making Choices	47.0	48.0	+ 1.0	0.023*
In the Future	61.2	58.8	- 2.4	0.013*
Outside of School	59.0	63.0	+ 4.0	0.013*

* Change is Significant at 0.05

Table 8

Student Opinions About Science When in STS Classes

	Pretest	Posttest	Change	Chi-Square
Science Classes Are:				
Interesting	75.4	75.4	+ 0.0	0.000*
Exciting	46.7	48.8	+ 1.1	0.046*
Difficult	18.7	16.9	- 1.8	0.030*
Science Class ...				
Gives Assistance With Knowledge of Careers	29.3	37.8	+ 8.5	0.000*
Provides Fun With Problem Solving Activities	57.9	59.7	+ 1.8	0.023*
Shows Technology Affecting Daily Living	51.2	55.6	+ 4.4	0.002*

* Change is Significant at 0.05

Table 9

Student Opinions About Science Teachers When in STS Classes

	Pretest	Posttest	Change	Chi-Square
Does Your Teacher ...				
Encourage you to Express Own Opinion?	25.4	31.7	+ 6.3	0.000*
Encourage you to Think for Yourself?	49.0	54.6	+ 3.4	0.000*
Encourage you to Be Creative	42.4	49.7	+ 7.3	0.000*
My Science Teacher ...				
Asks Frequent Questions	62.4	68.2	+ 5.8	0.000*
Likes Me to Ask Questions	65.4	72.0	+ 6.6	0.000*
Likes Me to Give Own Answers	77.1	81.8	+ 4.7	0.000*
Really Likes Science	73.0	78.0	+ 5.0	0.000*
Admits to Not Knowing All Answers	59.9	71.2	+ 11.3	0.000*

* Change is Significant at 0.05

Summary

The Iowa Chautauqua Program has enrolled 1,500 K-12 teachers during its seven year history. Assessment information permits the following statements regarding the advantages of STS instruction as it is defined and practiced in Iowa.

1. Concepts are mastered as well as they are with more direct instruction commonly found in traditional classrooms. However, in some instances students actually score significantly higher with respect to concept mastery. This seems to be caused by increased performance and interest on the part of average and below average students.
2. Process skills are developed to a significantly greater degree by students who experience their science in an STS manner. STS encourages students to use such skills themselves as opposed to using and practicing them in structured laboratories "to mimic what scientists do."
3. Creativity skills are significantly enhanced by STS instruction. Such growth is seen in STS classrooms taught by beginning STS teachers.
4. Attitude is enhanced by STS teaching. Student attitude, however, is much more positive when the teachers are more experienced and successful with STS.
5. Student ability to apply concepts is enhanced significantly when science is experienced in an STS format.

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AN ENERGY/STS SUMMER INSTITUTE FOR TEACHERS

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Abstract: The paper summarizes the history and development of Buffalo State's ENERGIZED TEACHING Summer Institutes for elementary, junior and senior high teachers. Topics, activities, funding and evaluation are included. A major shift to broaden the perspective of the Institute to include other STS topics was initiated in 1989. Results of this shift are highlighted.

History of ENERGIZED TEACHING

The ENERGIZED TEACHING Workshop series began in 1982, with a two week summer workshop for elementary (K-6) teachers funded by the U.S. Department of Energy. Following this initial program for thirty teachers, we continued to offer the summer institute each year through 1987. In the six summers of the original, intensive ten-day Institute for elementary and junior high teachers, over 200 educators from the Western New York region learned to integrate energy lessons into their existing curricula.

After the initial year of Federal funding, ENERGIZED TEACHING was supported by a number of electric and gas utilities which service the western New York and northwestern Pennsylvania area. Over the years from 1983 to the present, we have received workshop support from New York State Electric and Gas Corporation, National Fuel Gas Distribution Corporation, the New York Power Authority, Niagara Mohawk Power Corporation and Rochester Gas and Electric Corporation. CWM Chemical Services, Inc. will be a co-sponsor of the summer, 1990 program.

The STS Emphasis Expands

In 1989, we expanded our emphasis on science, technology and society issues in the summer program to include issues beyond energy. We indicated this new emphasis with a new title: ENERGIZED TEACHING in a Social (STS) Context Workshop, which is designed for teachers in grades 3-12.

Resource recovery, solid waste disposal, earthquake education and education about chemicals in society were the additional STS topics included in our newly expanded program. The general objectives of the current ENERGIZED TEACHING In A Social Context Institute include:

* to accurately and objectively discuss some major science, technology and society issues, including current U.S. energy use (which includes the laws of energy, energy conversions, efficiency and conservation, plus current and future energy options).
* to introduce teachers to existing energy and other STS-related curricula (units, films, games, etc.) for grades 3-12 including the New York Science, Technology and Society Education Project (NYSTEP), and the Chemical Education for Public Understanding Program (CEPUP).
* to demonstrate how energy and other STS issues can be infused into existing classroom programs in many subjects.
* to discuss and demonstrate classroom and field activities appropriate for students in grades 3-12.
* to show relationships to the State's syllabi in elementary and junior high science, plus social studies, technology and unified science (a high school course), and illustrate how energy/STS lessons can be developed using these resources.

Program Activities

Over the years, participants have included teachers of the elementary core (all subjects), science, English, social studies, reading, technology and consumer studies. Morning sessions generally focused upon energy/STS content and issues. Afternoon sessions included curricular activities appropriate to teaching concepts to children. In addition, teachers reviewed relevant energy/STS curricula, films and software, to identify teaching materials useful for their own classrooms.

The workshop's three instructors (two science educators, one earth scientist) were supplemented by a host of speakers with expertise in different topics. For example, an area high school earth science teacher talked about solar energy, and the solar greenhouse his students built at the school. A technology teacher talked about wind energy, and described the award-winning wind turbine machines his students designed. Two elementary teachers shared their ideas about designing effective energy/STS learning centers. Other speakers discussed energy from waste, State mandates in recycling, and earthquake education activities. A typical Daily Schedule listing all activities is available upon request.

Field trips are a highlight of any summer program, and ENERGIZED TEACHING included several all-day outings. For example, teachers saw first hand the region's most modern, coal-fired power plant equipped with state of the art pollution control equipment, and our State's largest hydroelectric plant. We also toured a chemical waste treatment disposal facility, and the Love Canal area of Niagara Falls, site of the first Federal disaster declaration for chemical contamination in 1978. Examples of energy-conserving/passive solar homes, and wind turbines were also featured during field trips.

NYEEP/NYSTEP Energy Materials

Each summer we highlighted the energy education materials originally developed by the New York Energy Education Project at the State Education Department with funding from federal sources and the New York Power Pool. [With a major materials development grant from the National Science Foundation, the Project has expanded its curricular development into other STS topics for the middle/junior high school. The Project is now called the New York Science, Technology and Society Education Project (NYSTEP).]

Elementary teachers were in-serviced with NYSTEP's *Energy and Safety: Science Activities for Elementary Students*, a series of 38 lessons for elementary students. The lessons pose questions for students to answer about energy, electricity, energy forms and conservation. Each lesson features a hands-on, inquiry based approach to science.

The middle/junior and senior high teachers were introduced to NYSTEP's junior high materials, which includes four student activity books: *Renewable Energy*, *Energy Conservation*, *Fossil Fuels* and *Nuclear Energy*. Each book contains six to nine activities, student directions, teacher background information, and a glossary of energy terms related to those activities. The materials also include transparency/ditto masters with energy maps, charts and diagrams, a set of student readings on various energy sources (at about the seventh grade reading level), and *Energy Futures*, a guide to Project materials with suggested lesson plans.

The in-servicing of NYSTEP project materials took place during NYSTEP Day, a day-long special session which included other non-Institute teachers who are interested in energy/STS education. Workshop sponsors also shared information and provided energy/STS sessions in a convention-style format during this day.

The Chemical Education for Public Understanding Program

In 1989 we added a day-long in-service workshop on CEPUP, a middle/junior high "chemicals in society" program being developed at the Lawrence Hall of Science, University of California at Berkeley. Supported by a National Science Foundation grant, and support from industrial and private foundations, CEPUP develops activity-based modular instructional materials. The goal of CEPUP is to develop greater public awareness, knowledge and understanding about chemicals and how they interact with our lives.

CEPUP modules introduced in the workshop (most appropriate in middle/junior high grades) included: *Solutions and Pollution* which looks at student's ideas about chemicals and then applies principles of acid-base chemistry to deal with some water pollution problems; *Determining Threshold Limits* which includes the concept of toxicity and limitations of extrapolating animal toxicity data to humans; and *Risk Comparison,* an introduction to the concepts of probability, risk, comparing risks, and decision making.

We included an in-depth review of a new CEPUP module, *Investigating Groundwater: The Fruitvale Story*, which features a hands-on simulation involving the contamination of an aquifer for a hypothetical community. Students investigate the source and extent of the contamination. Finally, as members of the community they try to decide what to do.

At the elementary level, *Chemicals, Health, Environment and Me* (CHEM) is being developed by CEPUP for fifth and sixth grade classes. We will include CHEM training in the summer, 1990 program.

Evaluation

At the end of each summer program, we conducted an evaluation of all of the program components. In general, the participants rated most components "very good" or "excellent". Overall program ratings from year to year have ranged from "very good" to "excellent" consistently.

Comments made by participating teachers over the seven years of ENERGIZED TEACHING indicated:

- the curricular materials and energy/STS information were useful and much appreciated
- the Workshop was a highly concentrated learning experience, but very enjoyable
- the program was a well-planned, valuable exposure to concepts and curricula which will be useful in their teaching
- field trips were a highlight of each summer's program
- materials and ideas were shared with colleagues in their district

Summary

The ENERGIZED TEACHING series continues as a popular, summer in-service teacher institute at Buffalo State College. Judged by teacher applications for the program, our new expanded energy/STS emphasis meets a pressing need for area educators. Numbers of applications for the 1989 program, which was the first which featured energy plus other STS issues, were an all time high in our seven years of experience.

Helping our participants to teach in a social context, and relating science to the real world of our students, continues as a primary objective of ENERGIZED TEACHING. Nearly 250 teachers from western New York and northwestern Pennsylvania have gotten "energized" in this Institute since 1982. Their enthusiasm for the program, and interest in energy/STS education continues to support and encourage our teacher in-service efforts at Buffalo State.

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[Note: CEPUP modules consist of a teacher's manual, and a kit containing CEPUP trays, chemicals and other necessary materials for module activities. For more information contact CEPUP, Lawrence Hall of Science, University of California, Berkeley, CA 94720. Telephone 415-642-8718.]
Chemical Survey & Solutions and Pollution
Determining Threshold Limits
Investigating Ground Water: The Fruitvale Story
Risk Comparison
Toxic Waste: A Teaching Simulation

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[Note: These curricular materials are available gratis to New York State teachers upon attending a NYSTEP Workshop. Out-of-state teachers may purchase the materials. For more information, contact Dr. William Peruzzi, NYSTEP Coordinator, New York State Education Department, Room 232-EMB, Albany, NY 12234. Telephone 518-473-1965.]

ELEMENTARY:

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Training Inservice Teachers for Improved Skills in Science and Technology Education

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There is considerable agreement among all segments of society that the science curriculum must undergo significant changes if it is to prepare students to meet the challenges of a technological society. In recent years a plethora of reports have been presented which support this viewpoint. Along with these reports have been recommendations from state departments of education, the Association for the Education of Teachers in Science (AETS, 1985), the National Science Teachers Association (NSTA, 1983), National Science Board (1983), the National Science Foundation (NSF, 1979), and the National Science Board Commission on Precollege Education in Mathematics, Science and Technology (NSB, 1983).

An underlying theme in each of these documents is that the K-12 science curriculum should extend beyond the structure of the discipline to its applied aspects, with an emphasis on the interaction of science and technology. The science curriculum cannot be isolated from the everyday lives of students. The integration of science, technology, and societal issues into the science curriculum is advocated as an important way of bringing about needed changes in education. Commenting on this same theme, the National Science Board Commission states:

> Although technological concepts are inseparable from their natural content in the sciences...the topic should be considered of critical importance and meriting separate treatment. Appropriate instruction in technology should be integrated in the curriculum. Doing so will serve to strengthen the teaching of technology literacy. This will require a major emphasis on the development of new teaching materials

> and on the training of teachers to enable them to handle technological concepts (p. 6).

It was within this framework that East Tennessee State University developed a graduate level course entitled "Science and Technology". The course was designed for inservice teachers at both elementary and secondary levels. The aim of the course was to demonstrate the interaction of science, technology, and society and present effective ways to integrate science/technology/societal issues into the curriculum. We are convinced that an understanding of technological concepts and their application is essential if students are to function in a technological society. For more than two decades, ETSU has directed energies at training large numbers of K-12 science educators in the area of scientific literacy. The major thrust of these efforts has been the development and implementation of National Science Foundation funded programs for inservice teacher training. However, the Science and Technology Course was not designed and implemented until the summer of 1987.

Course Development

Two years prior to the development of the course, the project directors made numerous contacts in the form of discussion and correspondence with elementary and secondary science teachers in Northeast Tennessee to identify basic needs related to science programs. In 1986, a questionnaire was administered to science teachers in the university's service area to further determine needs and concerns pertaining to the science programs. More than 300 science teachers completed the questionnaire. The data revealed that teachers did not feel confident with their content knowledge relating to the interaction of science and technology, but they were even less knowledgeable about demonstrated teaching methods for dealing with the interaction of science, technology and societal issues. The data further revealed a lack of appropriate curricular materials that dealt with science and technology education. The data also suggested that resources of local industries should be utilized to more effectively integrate science and technology in the curriculum.

Based on the results of the needs assessment and feedback from local industry, a course proposal was developed and subsequently funded by the Tennessee Higher Education Commission. It was at this point that potential faculty members in other colleges were interviewed to see if they enthusiastically endorsed the goals and objectives of the project. After initial contact with each faculty, a series of contacts were made through telephone conversations and correspondence to determine how each individual would contribute. To further the collaborative nature during the developmental and implementation phases of the project, a Science and Technology Committee was established in April of 1987. The committee consisted of thirteen teachers (one from each of the thirteen school districts in the ETSU service area) the Dean of the College of Education, faculty members, and industry representatives. Representatives from Tennessee Eastman Company, Raytheon Corporation, TRW, Great Lakes Research, and Nuclear Fuel Services discussed with the group their perceptions of the program and how their resources and expertise could fit into the project plan. As an outgrowth of this meeting and subsequent contacts with local industry, specific resources and consultants were identified.

Throughout the development and implementation of the course, the program served as a model of collaboration involving the Colleges of Education, Applied Health, Biological Sciences, Medicine, Arts and Science, Tennessee Higher Education Commission, local school districts, and local industries.

Course Goals

The content of the course was built around four major units of study as outlined in Table One. The primary theme of the course was to show the interrelationships between science, technology, and societal issues. The goals of the course are outlined and discussed below:

I. To develop improved knowledge and understanding of technology-related concepts among elementary and secondary science teachers.

Technology provides the focus for many issues: robotics, microcomputers, hazardous waste, acid rain, genetic engineering, and organ transplants are but a few of the many issues that exemplify the importance of technology. However, personal and societal issues emanating from these topics should not diminish a knowledge base of science and technology by the participating teachers. With this in mind, and in order to meet objective number one, each consultant nurtured the content of the workshop in light of the interaction of science, technology, and society, and the individual's role in each. For example, the mode of instruction followed this format: (1) historical evolution of the science and technology, (2) the scientific and technological developments and their possible societal application, (3) analysis of issues associated with the science, (4) discussion of the social, economical, political, legal, and ecological ramifications of the issues, and (5) consideration of the tradeoffs associated with the technologies. As teachers' attitudes toward science and technology concepts were enhanced, they were led to consider the pros and cons of the contributions of the developments and their personal and societal implications.

II. To develop teaching resources that show the interrelationships of technology, science, and societal issues.

The development of curriculum materials for teachers to utilize in their existing science curriculum areas was a joint venture by all those involved in the course: university faculty, consultants from industry, workshop directors and teachers. It was the opinion of teachers that textbooks did not provide adequate coverage of science and technology issues, especially as they related to local concerns and issues. Prior to the course, and during the planning stages of the program, teachers were provided with background information on each of the topics that was covered in the course. Utilizing these materials, reading assignments, and coverage in the classroom, instructional materials were developed throughout the duration of the project. The development of curricular materials followed the same format that was utilized during the instructional phase of the project as was outlined under objective one.

As an example of course content, one instructional unit was developed around the study of radon gas. Radon gas is a naturally occurring radioactive element, a radionuclide gas, found in soil and rocks that make up the earth's crust. Since the geological strata in many Northeast Tennessee counties have been identified for their potentially high radon risk, several student learning activities were developed around this topic. These materials provided the teacher with content and activities necessary for students to do a thorough study of radon. The activities provided content background on radon and instruction to investigate the issues associated with radon gas. The activities provided both issue investigations and evaluation; leading students to become involved in actual investigation, including data collection, interpretation of results and communication of findings among the several schools represented in the course. In essence, the curricular materials encompassed knowledge skills, plus an opportunity for students to investigate, analyze, and understand science and technology issues.

III. To develop an alliance between schools and industry/business for the purpose of promoting science and technology education in the school curriculum.

The Science and Technology Committee, described earlier, was formed early in the planning stage of the course. The committee brought together a large number of organizations with the task of improving science and technology education. Prior to the initial meeting of the committee, the program directors asked the teachers (those serving on the committee) to survey other teachers in their respective school districts concerning their perceptions of how local industry/business can contribute to the success of their science program. The six most frequently stated needs were as follows: (1) establishment of a visiting scientist program by industry to enhance the science program, (2) field trip tours for students to local industries, (3) summer internships for science teachers to work side-by-side with researchers, (4) donation of laboratory equipment to enhance science instruction and (5) programs for the retraining of elementary teachers in K-6 science. Teachers presented results of the needs assessment to representatives of local industry/business and other organizations during committee meetings. As a result of this interaction between these agencies a program has been established whereby the schools are receiving resources from these local agencies.

Since the content coverage in the course was varied and not structured in any particular fashion, no single textbook was utilized in the project. Reading material was assigned that stressed the current nature and recent developments of various topics covered in the course. Reading materials came from periodicals, newspapers, books, materials, and other resources shared by instructors. For the most part, the class was team-taught by the various consultants and instructors involved in the project. For example, a team of five consultants from Texas Instruments team-taught five classroom sessions on computers. The topics included semi and super conductors, opto-electronics, factory automation, robotics, and artificial intelligence. Each instructor, based on his/her expertise, brought a unique approach to the course. In additional to lecture, discussion, and demonstrations, other formats of instruction such as video presentations and field trips were used as appropriate.

Selection Criteria

Admission to the program was very competitive and tuition was provided by a grant from the Tennessee Higher Education Commission. Criteria for selection included evidence of strong science instruction in the classroom, a minimum of two years of successful teaching experience at the pre-college level, and recommendations from the local school district. Teachers learned of the program through announcements and applications that were sent to curriculum directors, science supervisors, principals, and science department chairs. Twenty-five participants were selected for the project each summer.

Teachers received three hours of graduate credit for successively completing the course. They spent five weeks, three hours per day, in lecture/laboratory instruction and developing curricular materials. The first half of each class period was devoted to discussion and lecture, while the second half was devoted primarily to laboratory work and demonstrations. Even though much of the time devoted to curriculum development took place outside of class, a portion of a class was set aside each week for this purpose.

Project Impact

During the academic year, subsequent to the summer course, the participants returned to their respective schools to utilize what they learned while on campus at East Tennessee State University. An important outcome of the project was the "ripple effect". Participants worked with their peer teachers by helping in the planning of instruction, and by doing demonstration teaching techniques. The participants in the course conducted inservice sessions for teachers in their district. The 1987 participants who completed the summative questionnaire reported they conducted inservice for more than 300 teachers. In addition, curricular changes came about as a result of participants' schools incorporating the teacher developed curricular materials into the existing science curriculum.

The alliance provided consultants for the summer course and resources during the academic year. For example, programs and projects include conferences, inservice teacher workshops, a speaker's bureau, small grants for teachers, equipment donation, curricular assistance, tours, content seminars, and visiting scientist programs. Tennessee Eastman Company initiated a summer internship program for science teachers to work side-by-side with researchers. Not only do teachers participating in this program gain valuable research skills, they are paid $5,000.00 for a ten week period. The local chapter of the American Chemical Society sponsored competition in high school classes to recognize outstanding chemistry students, plus many other activities in support of science teaching.

The project staff provided an on-going support for participants during the academic year, including contact via written reports, assistance at inservice and staff development meetings, arrangement for guest classroom presentations, and assistance with any concerns and needs.

Course Evaluation

While evaluation has varied slightly due to the training and experience of participants, middle school and secondary teachers completed two, take-home exams (essays). The first exam was administered mid-way through the course and the second exam was given out three days prior to completion of the course. The students were given until the last class meeting to complete and return the exams. On each exam, questions were written in such a fashion that they elicited from participants a logically organized and coherent response from a variety of topics presented during class lecture. Since the course was team taught by several different consultants, each instructor was responsible for developing the questions and evaluating the students' responses. Both exams accounted for 75% of the students' final grade. The remaining 25% of the grade resulted from a written project that required each student to develop ten lesson plans that would be incorporated into his/her curriculum during the academic year. A wide array of topics was selected around which lesson plans were developed. Examples of topics are as follows: organ transplants, genetic engineering, land-use management, computer technology, ozone depletion, household chemistry and fiber optics. The lesson plans were edited and evaluated by the project staff and bound in booklet form. The booklets were prepared for the grade level of participating teachers, with project staff contributing several additional modules. Participants' responses to the course were positive and enthusiastic. Examples include, "the experience of participating in this course was one of the most enlightening and interesting college level courses of which I have been a participant."; "...my understanding of S-T-S issues have been profoundly increased."; and "It was an interesting class and I'm looking forward to involving my students in the activities I developed in my lesson plans." Teachers have an inherent interest in technological issues associated with the varying topics covered in the course. By capitalizing on this interest, the project is having an impact on the school science curriculum.

Conclusion

The Department of Education publication, A Nation at Risk, expressed concern over our future as an economic, political, and technological world leader and called for changes in the science curriculum. If students are to compete in a world economy, they must be technically literate. Students must be prepared to make decisions about such critical issues as pollution, biotechnology, energy resources, and nuclear war. The ETSU Science and Technology course seeks to address these concerns. However, it must be realized that such a project does not provide a ready-made panacea for the many curricular problems and conflicts within the field of science education. It does provide a foundation upon which others can build a cyclic process of design, development, trial, evaluation, and revision of urgently needed unique approaches to science-technology-society education.

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Table One

Course Outline

I. Biotechnology
  - * genetic engineering
  - * organ transplant
  - * artificial organs
  - * X-rays
  - * laser medicine
  - * research

II. Computers and their application
  - * fiber optics
  - * semi and super conductors
  - * robotics
  - * artificial intelligence
  - * video disc
  - * retrieval of data
  - * research

III. Chemistry
  - * patents and inventions
  - * food preservatives
  - * gasification
  - * polymers
  - * household chemistry
  - * research

IV. Energy, Resource Management, Conservation
  - * herbicides, insecticides
  - * mining
  - * acid rains
  - * toxic waste
  - * nuclear reactors
  - * research

THE GYPSY MOTH IN THE CLASSROOM:

A SCHOOL-BASED APPROACH TO GYPSY MOTH EDUCATION

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The gypsy moth is one of the most despised and persecuted insects in America. Federal, state and local governments have spent millions of dollars and sprayed tons of dubious chemicals against them. Yet the gypsy moth continues to spread and prosper. What was once a problem of the Northeast is rapidly becoming a national problem. There is every reason to believe that sometime in the future gypsy moths will be found all across the United States, wherever there is hardwood forest.

Activity is on the increase. In 1989, New Jersey reported a nineteen-fold increase in the number of acres defoliated, while Pennsylvania in 1990 is expected a record breaking year for defoliation: 2.5+ million acres. In 1989, Iowa had more detections of gypsy moth than ever, while in 1990, Utah anticipates spraying 20,064 acres in three counties near Salt Lake City. The need for education about this problem seems obvious.

The "Gypsy Moth in the Classroom" project is a school-based program designed especially for elementary and middle school grades. The project was developed in 1988-89 with a grant from the USDA Forest Service, Northeastern Area, State and Private Forestry, Radnor, Pennsylvania. The project was done in cooperation with the New Jersey Department of Agriculture, the New Jersey Division of Parks and Forestry, and the West Deptford Township Schools, West Deptford, New Jersey.

What makes the project unique is that elementary students and their teachers actually rear gypsy moths in their classrooms, from eggs to adults. The gypsy moths are reared from mid-March to mid-May using an artificial diet. During this time, students participate in a series of activities designed to teach them and their parents about the gypsy moth, how people can work to control them, and other lessons about the environment.

The project was "field-tested" in the Green-Fields Elementary School, Woodbury, New Jersey, in the Spring of 1989. Participants included five elementary teachers and their classes. The final product of the pilot program was a curriculum guide for elementary teachers, first released in August, 1989. The guide includes sections on the history and life cycle of the gypsy moth, classroom rearing techniques and a series of classroom activities complete with reproducible student worksheets. The project is easy to start, easy to run, inexpensive, and requires minimal space in the classroom.

People who hear about the project for the first time usually say, "Surely there are enough gypsy moths out there already. Why do you want children to raise even more? What if the caterpillars escape?" There are several responses to this question.

First, the project does not create more gypsy moths. The project begins in late winter with the teacher finding an egg mass outdoors and bringing it into the classroom. The egg mass would have hatched anyway. It may as well hatch in the classroom where it can do some good. In fact, anywhere in the United States where egg masses can naturally be found, it makes sense to encourage teachers to raise them in the classroom as an aid to public education.

Where gypsy moths cannot be found locally, we do not recommend that teachers send to other locales or states to get them. This would be foolish and illegal: there are quarantine regulations that prohibit transfer of live gypsy moth material outside the generally infested Northeastern states and Michigan. Nevertheless it is possible to do the project in states outside the quarantine area. This can be done by using some of the activities in the project that do not require raising live gypsy moths and better yet by raising live tent caterpillars as a substitute. Tent caterpillars are found across the United States and are often confused with gypsy moth caterpillars. A section on rearing tent caterpillars as a substitute for gypsy moths is included in the teacher guide.

When live gypsy moths are reared in the classroom, due to the timing of the rearing project, from mid-March to about mid-May, escapes are not a problem. Caterpillars that escape in March and April do not have foliage to feed on and will starve. Adult males that escape in May cannot find wild females to mate with are drawn back to the classroom by the lure of the captive females.

In fact, it is the timing of the project that gives it immediate relevance and significance to students. Just when the project concludes in May, wild gypsy moths are becoming a visible nuisance outdoors.

Another question often asked is, "Why not raise them in high school classes, instead of elementary school classes?" The project was developed in elementary grades for a number of reasons.

Unlike teenagers and adults, young children are less likely to have "hardened" attitudes about "bugs and other crawly things." Elementary school children are curious about insects, take an interest in them, and are less likely to find them offensive.

Elementary school students are also more enthusiastic about school in general and science in particular, than older students. Younger students are much more likely to go home and talk to their parents about school activities. Since it is a goal of the project to educate parents as well as students, this is an important consideration.

Elementary teachers typically have few science resources and materials to work with, and almost no budget for obtaining them. yet many elementary teachers like doing science with their students because they know that their students enjoy science activities. As a result, successful elementary school science programs need to be inexpensive. Most materials in the gypsy moth project can be begged, borrowed, or substituted for, while ten dollars of artificial diet will raise a small army of caterpillars.

Adding gypsy moths to a classroom should not be viewed as an attempt to replace part of the science curriculum. Gypsy moths can be used to illustrate many topics that elementary teachers already teach, such as insects, food chains, animal populations, and so on. Rearing caterpillars provides students with an interesting activity, in the same way that teachers often have gerbils or other small animals in a classroom. Teachers can spend as little or as much time on the project as time permits.

The Gypsy Moth in the Classroom project was expanded in 1990 with funding from a second grant. A major focus of the grant was an aggressive effort to get the project into the hands of teachers and educators who will use it. This effort included workshops and presentations at the local, state, regional, and national levels. Accessory materials including a board game and videotape have been developed.

An attempt will be made to quantify the educational benefits of the program to parents. Many societal problems cannot wait ten years for students to grow up and become adults. Traditional parent/student partnership programs have focused on using parents to further the education of their children. Seldom has a partnership program worked the other way, using students and their school activities to educate parents. The study may reveal the extent to which students and schools, through a reversal of the parent-child partnership, can make an immediate contribution to the solution of a social and environmental problem.

The final word on "The Gypsy Moth in the Classroom" should be given to those who have seen or used the project. Their reaction has been overwhelmingly enthusiastic: "outstanding quality and professional execution" (Northeastern Area Association of State Foresters), "truly an inspiration to those of us involved in gypsy moth education" (Nancy Campbell, Michigan District Extension Leader), "the best resource on the gypsy moth I've seen in twenty years as an agricultural agent" (Ed Milewski, New Jersey Agricultural Agent, "the teachers are excited and motivated" (Susie Oliphant, Washington, D.C., Director of Curriculum for Science), "informative, interesting, accurate, and well-balanced" (Bill Wentzel, Forestor for Washington County, PA), "extremely well presented, organized and understandable" (Harold Kuschnik, Ganaraska Region Conservation Authority, Ontario, Canada), "innovative and presented with considerable imagination" (Alan Cameron, Professor, Penn State University), "the multidisciplinary format allows it to be used by many different teachers" (John Neville, Environmental Educational Supervisor, Prince Georges County Schools, Maryland), "congratulations on a job well done" (Bill Hatfield, Hatfield Spraying Service, Nunica, Michigan).

Curriculum guides (free) and other materials are currently available from Erik Mollenhauer, Project Director.

THE IOWA CHAUTAUQUA PROGRAM: THREE MODELS FOR DEVELOPING STS PROGRAMS IN THE ELEMENTARY SCHOOL

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In 1982 NSTA developed an experiment funded by NSF to determine the power of the AAAS Chautauqua model which had been in operation for nearly 15 years as a way of up-dating and improving undergraduate science instruction in colleges. Basic to the model is a short course (two to four days in duration) in the fall of the year headed by an expert who was involved with some research or development that could (should) affect science instruction. After such introduction to new ideas and/or procedures, teachers were charged with using the new information in some way to improve their own courses. This use of information from the initial short course was called an interim project. After a duration of three to six months a second short course was conducted for a similar length of time. The focus of this second short course was to hear reports of the interim projects completed, the reports of assessment efforts, an analysis of the projects by the course instructor(s), and plans for continuing communication among participants and between participants and staff. This AAAS Chautauqua Model was adapted by NSTA as an experiment to test the validity of the model for improving science teaching in K-12 institutions.

Iowa was selected as one of 20 state sites for testing the Chautauqua model. Figure 1 provides a diagram that depicts the Iowa Chautauqua Model when it operates fully with support from Iowa Utility Association (IUA), other industries, NSF, Title II-Eisenhower funds, and schools/community colleges/public universities.

FIGURE 1: THE IOWA CHAUTAUQUA MODEL

*** TWO WEEK SUMMER WORKSHOP ***

An STS Experience
1. Includes special activities and field experiences that relate specific content within the disciplines of biology, chemistry, earth science, and physics.
2. Makes connections between science, technology, society within the context of real world issues.
3. Issues such as air quality, water quality, land use/management are used as the context for concept development.

*** ACADEMIC YEAR WORKSHOP SERIES ***

Fall Short Course		Interim Project		Spring Short Course
Awareness Workshop 20 hr Instructional Block (Thursday pm, Friday, & Saturday) Activities include: 1. Review problems with traditional view of science and science teaching 2. Outline essence of STS 3. Define techniques for developing STS modules and assessing their effectiveness 4. Select a tentative module topic 5. Practice with specific assessment tools in each STS Domain	----->	Three Month Interim Project The STS Module 1. Developing instructional plan for minimum of twenty days 2. Administer pretests in five domains 3. Teach STS module 4. Collect posttest information 5. Communicate with regional staff, Lead Teachers, and central Chautauqua staff	----->	Final Workshop 20 hr Instructional Block for Thursday pm, Friday, & Saturday) Activities include: 1. Report on STS experiences 2. Report on assessment efforts 3. Interact on new information concerning STS 4. Plan for involvement in professional meetings 5. Plan for next-step STS initiative

The focus in Iowa were the Science/Technology/Society (STS) materials and teaching style which emerged from the Project Synthesis report which had been published by NSTA (Harms and Yager, 1981). STS efforts were seen as a specific response to the general failure of typical textbooks or curriculum programs to address the first three goal clusters (justifications) for school science programs (nearly everyone justified their curriculum efforts because the structure was seen as a way of preparing all students for further study of academic science). The three "ignored" goal areas include:

1. **Science for Meeting Personal Needs.** Science Education should prepare individuals to use science for improving their own lives and for coping with an increasingly technological world.
2. **Science for Resolving Current Societal Issues.** Science education should produce informed citizens prepared to deal responsibly with science-related societal issues.

3. **Science for Assisting with Career Choices.** Science education should give all students an awareness of the nature and scope of a wide variety of science and technology-related careers open to students of varying aptitudes and interests.

In Iowa the STS program from elementary and middle school programs were further characterized as programs which could be characterized with the following features:

1. the identification of problems with local interest/impact as course lesson organizers;
2. the use of local resources (human and material) to locate information that can be used in problem resolution;
3. the active involvement of students in seeking information that can be applied to solve real-life problems;
4. the extension of learning activities beyond the class period, the classroom, the school;
5. a focus upon the impact of science and technology on each individual student;
6. a view that science content is not something that exists for students to master for tests;
7. a de-emphasis upon process skills--just because they represent glamorized skills of practicing scientists;
8. an emphasis upon career awareness--including the vast array of careers related to science and technology in every community;
9. opportunities for students to perform in citizenship roles as they use science and technology concepts and skills to resolve issues they have identified;
10. identification of ways that science and technology are likely to impact the future.

A grant from NSF supported the Iowa Chautauqua Program for a three year period (1983-86). After the first year the Iowa Utility Association (IUA) agreed to support the program thereby increasing the number of sites and teachers served by a factor of three. After the three year NSF grant, another grant from NSF was awarded to The University of Iowa to support the Chautauqua effort for another three year period. Currently the IUA, NSF, and supporting state and local institutions provide about $300,000 collectively per year to support the effort. Funds from Title II (Eisenhower Act and Iowa Lottery) have assisted with support for teacher stipends, travel, and direct expenses, especially those associated with one to three week summer workshops to introduce the STS philosophy to key teachers from new districts.

A vital part of the Iowa Chautauqua Model is the involvement of Lead Teachers as a significant part of the instructional team. When the program began two experienced and enthused STS teachers were chosen for key staff positions. Following this all of the most successful STS teachers have been invited to join the Lead Teacher Cadre each year. Those who accept the invitation agree to participate in an annual Leadership Conference (held on campus each July) and supported by direct funds for IUA. During this conference the staff teams are selected for each of the five new sites selected from across the state where interest in hosting such a series has been shown. All Lead Teachers are involved with planning the schedule for one or more Chautauqua sites for the next year, to attend and to present at a variety of state, regional, and national meetings, to experiment with new STS materials (e.g., Chemistry Education for Public Understanding Program as supported by Sandoz Crop Protection), and to conduct new experiments regarding STS in their own schools. For the most part, all Lead Teachers have moved to structuring their entire courses as ones meeting the STS criteria listed before. The efforts of Lead Teachers results in all kinds of reports concerning their successes with STS and results in new calls for workshops and school involvement with specific reforms in the STS arena.

Three of the most successful lead teachers associate with the Iowa Chautauqua Program are in three elementary schools in Iowa. They are:

1. Janet Dunkel, 6th Grade Teacher, Jefferson Elementary School, Charles City, Iowa 50616
2. Veda Flint, Science Specialist, Northeast Elementary, Glenwood, Iowa 51534
3. Joan McShane, Science Coordinator, Jefferson Elementary School, Davenport, Iowa 52804.

Examples of their STS efforts provide most powerful definitions of STS in action. Their experiences provide information concerning what it means to focus on STS in the elementary school.

Classroom in the Community. Janet Dunkel

Students raising questions about environmental issues they have encountered during the summer break is the tone set on the opening day of school. What observations students have made of the environment can be found in all curriculum levels and areas of science in the Charles City sixth grade.

Students cooperate in searches for articles and questions; they explore the known and unknown for answers. Is refuse a problem people can control? Can each person help solve the refuse problem if they realize their responsibility? Does pollution affect the senses of people? What affects does pollution have on the senses of people? Is refuse used by people to help maintain a beneficial environment while also providing useful projects? Is the environment being harmed by pollution? Are herbicides and pesticides harming our natural environment? Questions continue to be generated as students involve themselves in searching for answers. Raising questions is a never-ending process. They provide student/class ownership and establish a need for knowing.

While researching and investigating the issues, students use many strategies to gather information pertaining to their questions. Experimentation becomes an exciting activity. Discovery of ideas provides reality through experimentation and in such activities as weighing the garbage and checking for plastic, paper, and glass. The resources of the community are discovered by planning group field trips, by writing letters for information, and by inviting experts into the classroom (elected officials, DNR officials, EPA employers, farmers). Students generate creative solutions and actions. These include surveys of the community for assessment, games for younger children, editorials, toxic waste cleanup, building houses of garbage, and authoring books.

After surveying and assessing the community about the issues in Charles City, the students decided to take actions at the county level. They targeted plastic recycling as a major problem; they found that many plastics are used for only a few moments and then discarded. A plastic recycling project was developed where students collected, sorted, baled, and transported plastic to a contractor for re-use. The students made all arrangements and have used the money to purchase two recycled plastic park benches for the school yard.

What If The Birds Stopped Singing? Veda F. Flint

Students at Northeast Elementary School in Glenwood, Iowa, have a unique opportunity to experience environmental education. A wildlife center was established on the school grounds through a cooperative effort involving students, staff, and community.

The vision for this nature center evolved from a concerned student's question, "what if the birds stopped singing?" Having been trained through the Iowa Chautauqua Program-Science, Technology, and Society (STS), I perceived an enthusiasm in the students and staff to gain more knowledge and experience with environmental issues and their applications to everyday life. This enthusiasm and concern about man's relationship to nature, and a student's question, "What if the birds stopped singing?" led to an in-depth study based on three questions proposed by my students:

1. What is happening to our natural habitat?
2. How does our survival depend on the habitat?
3. How can we make a difference?

As a result of this study, it was determined that students needed an outdoor center in which to investigate these questions. We could make a difference by using part of our school grounds for an outdoor learning center.

My students and I realized we couldn't accomplish this alone. Concerned fifth grade students visited with Mr. McGinnis, our principal, about the feasibility of developing a center. He was very receptive to our idea. Together we examined the school grounds to determine a site best suited for a Wildlife Center. The chosen site was a forgotten, barren location on the school grounds.

The Northeast Elementary Educational Center has become a reality. Careful planning and organization were responsible for bringing a student's questions posed in January into fruition in May.

In February, we invited Elaine and Robert Sabin, teacher-naturalists, to present a slide show of their own backyard conversion to the staff and students.

In March, a committee of students, teachers, and community members met to discuss possible direction for the site. Job descriptions were defined for subcommittees and deadlines were set. The subcommittees included site planning and preparation, procurement, publicity, fundraising, presentation, community contacts, and parent involvement.

On March 15, a picture and an article promoting the nature center was published in the Glenwood Opinion Tribune. Students sent letters to parents explaining the project. Fund-raisers were planned in the forms of a faculty basketball game, proceeds from selling student-made nature gifts, and a membership drive for a newly created Northeast Naturalist Club. Students were proud that they had made the first $500 for the center.

Students and committees rallied to meet an Arbor Day deadline of April 20. Service organizations were contacted. Students, following a plan sketched by horticulturalist Jan Riggenbach, made a model of the proposed center which was useful when presentations were made to service groups.

The procurement committee had contacted the Terry Nursery to obtain plantings. Boy Scout Troop 243 outlined a nature trail to be filled with wood chips donated by Iowa Power and Light.

On Arbor Day, students, staff, and guests participated in a dedication ceremony. Several groups of students presented skits using environmental themes. Following the ceremony, all students moved to the nature center to plant a miniature time capsule with each tree.

Students, staff, and volunteers proceeded to meet the next deadline, the final day of school. More plantings were added, the wood chip trail was finished, and a footbridge was built. Volunteer dedication and effort enabled the center to survive during Iowa's summer drought. In the fall of 1988, a trellis was built to support honeysuckle, bittersweet, and trumpet vines which will attract, shelter, and feed the birds. Bird feeders were placed throughout the center. Students were ready to give guided tours to parents and other interested visitors during the annual ice cream social in September.

The year 1988-89 became known as "The Year of the Wildlife Center". It was the pivotal point of many activities. The activities assisted and motivated learners of all ages to begin to develop the awareness, skill, knowledge, and commitment to improve the quality of the environment upon which all life depends.

Judging from the document amount of activities and the variety of curriculum areas, it can be stated that teachers and students succeeded in meeting our educational goal which was to initiate the site. Teachers and students were innovative in discovering activities which correlated to the issue of man's relationship to nature. Instructors discovered that environmental education is truly multidisciplinary. Various instructional methods were used to achieve the educational goals. These methods involved problem-solving, hypothesizing, observing, interviewing, testing, predicting, modeling, investigating, creative writing, drawing, and direct "hand-on" activities.

Informal procedures of evaluation have been used to assess the learning outcomes. Each curricular area has developed its own set of criteria with which to evaluate the student activities.

Formal pre-testing and post-testing methods were primarily used in science classes. However, formal evaluation of the multidisciplinary curriculum is being developed as part of our curriculum study and long-term goals. A very impressive outcome of the project has been the pride and ownership that has developed in the staff and students. This pride has been accentuated by positive community and state-wide recognition.

Iowa's Governor Terry E. Brandstad visited our center and presented the school with the FINE award, "Finest In the Nation in Education". He enjoyed listening to the birds sing and became an honorary member of the Northeast Naturalist Club.

A Favorite Three-Letter-Word. Joan McShane

"Love" is perceived to be the universally favorite word; however, being an elementary science teacher, my favorite word is "why", often expanded to "why not"?

Most of my STS units have evolved from students' questions about the events in their lives occurring in their school, in their homes, and in their neighborhoods. "Why" and "why not" as well as "how come" are frequently the impetus for a science project in my classroom. One of my favorite projects, the testing of forty-three different brands and kinds of toilet tissue, began with a sixth grade student coming late to class and describing in graphic detail what had happened at his house the night before because of a clogged toilet caused by toilet tissue. His class was studying water ecology and when the student related how much water was wasted at his house that night and that toilet tissue was the culprit, a member of the class asked "Why can't we experiment to find out what tissue would be the best to use to avoid clogged toilets that waste water as well as those that break up best and would be the least likely to pollute the Mississippi River (our city's water source)?"

The unit developed with the students gathering tissue from merchants in the area, working with a parent to build a full-sized portable commode in the classroom, dividing themselves into thirteen data gathering groups, and spending six weeks measuring, weighing, flushing, and observing toilet tissue. The result was that the student learned to gather, compile, and draw conclusions from data. They learned which tissues were ecologically and practically the best to use. Sharing this information, they issued a report to the fifty community people who helped them with their project. These sixth graders addressed a concern in their community, and they conducted a project that gave consumers information to enable them to make thoughtful, positive ecological choices in their buying habits of a product used by EVERYONE - toilet tissue.

Another STS project came from a newspaper article, "Suds Kill Fish". This article prompted a discussion in a sixth grade science class concerning detergent suds in the Mississippi River. A student asked, "Why don't we find out which laundry detergents make the least amount of suds?" Another student added, "My mother doesn't care about suds, but she wants to know what detergent gets stains out the best." These two inquiries resulted in the students installing a full-sized washing machine and suds collector in the classroom. They gathered thirty different washing detergents, used twelve different stains and tested which detergents produced the least amount of suds and at the same time removed stains.

For eight weeks, stained cotton cloths agitated through the washing and rinsing cycles while students measured the suds produced, the detergents' dissolving abilities, and the detergents' stain removing abilities. At the end of the testing, the students compiled their data and issued a report informing the community which detergents were the best to use. Again, these sixth graders has addressed a community issue and had completed a project that gave valuable information to the citizens in their city.

A third favorite STS project resulted from a student sharing his frustrations with his classmates about cavities in his teeth. This young man returned from the dentist to class with a swollen jaw and a depressed attitude because the dentists said the student was not getting his teeth clean. His good friend queried, "I wonder if all toothpastes are the same? Maybe your brushing is 'O.K.", but it's your toothpaste that isn't getting your teeth clean. Why not 'check out' your toothpaste compared to others?" This question prompted a research project that involved students in gathering "real" teeth from oral surgeons, implanting them in dental acrylic, staining them with various foods and saliva, and then brushing them with twelve popular and/or dentist recommended toothpastes.

The students compared the cleaning abilities of the toothpastes and also tested the rinse water to see if any chemical change occurred when the toothpastes mixed with the water. After five weeks of testing, the students learned one toothpaste was outstanding in its cleaning and stain removing abilities.

The student shared the result of their project with the oral surgeons and dentists who helped them and with parents, peers, and interested citizens - the community.

It is these kinds of STS projects that I feel exemplify to students that science is something we use every day in a meaningful, helpful, productive way. Science is not just a subject; "it" is present in everything we do and its processes can help us address and work toward solving issues of concern in our communities.

The "why's" and "why not's" might not always be completely answered, but my students and I certainly have fun searching for the explanations!!!!

In Summary

Some exciting results which occur in classrooms when lead teachers are contrasted with sections where traditional materials and teaching strategies are used. Some of these results have been reported previously (Yager, 1987; 1989a; 1989b; Yager, Myers, Blunck & McComas, 1990). Generally, these studies have focused on student outcomes in five domains as described by Yager and McCormack (1989), including concepts, processes, attitude, creativity, and applications. When studies involving enthused and experienced STS teachers are involved the following advantages of STS are observed:

1. STS students master as many science concepts as do students taught in traditional sections. In some few instances, STS students have mastered more concepts than students studying science in a more traditional way, i.e., concept mastery is considered of utmost importance and something that must be accomplished before other goals can be considered.
2. STS students master process skills twice as effective as students in the same grade level who experience science in traditional ways.
3. STS students have two times more positive attitudes concerning science courses, teachers, study, and careers than do students in traditional courses.
4. STS students have four times greater creative skills than do students in traditional classes; these included questions generated, causes hypothesized, and consequences predicted as well as the uniqueness of all three.
5. STS students are three times more successful with the applications of science concepts then are students in traditional classrooms.

To date the Iowa Chautauqua Program has served nearly 1,500 K-9 teachers. A total of 50 Lead Teachers have enrolled in Leadership Conferences and continue as a part of the instructional staff and the assessment team. The model exists as one with a proven record for attracting teachers, stimulating curriculum and instructional changes, producing evidence in terms of improved student performance with STS approaches. It is a model worthy of transport and use in other states. It has changed teacher perceptions of science, developed exemplary science teaching practices, and produced desirable science curricula for over 100 school district. It has promoted the formation of a continuing and growing communication network of teachers interested in improved science for the students with whom they are privileged to work.

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TECHNOLOGY PROCESS SKILLS FOR THE ELEMENTARY GRADES

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We have long taught the science process skills--the hands-on part of science. Technology, like science, also has both a process and product component. Technology as a curriculum component does not have a long tradition of appropriate process skills.

The purpose of this paper is to share the technology process skills introduced to preservice elementary teachers at Utah State University. In this program, technology as process is defined as the application of knowledge to satisfy human needs and wants and to extend human capabilities. The needs and wants component of the definition implies that technology relates things such as perfume, shelter, food, and VCR's. Second, technology addresses the extension of human capabilities such as the computer to extend the brain. Technology is a human endeavor consisting of a variety of processes that utilize material resources.

It should be pointed out that the STS curriculum at Utah State University is constructive; that is, emphasis is on the positive aspects of science and technology, interactions with society, and not the issues-only oriented approach of many STS curricula. In the constructive framework, students are encouraged to be creative, inventive, and experience the manufacture of a product.

The section that follows is an outline of a process used to achieve a constructive attitude toward technology.

The process begins with exploring aspects of inventiveness. Inventions require intelligence (people) and stuff (materials).

How does one get a student's brain going? Where do the ideas for inventions come from? It is assumed that inventiveness is promoted by a resource rich environment, by an appropriate educational atmosphere, and by learned behaviors. To increase the level of inventiveness among all students, the curriculum should be structured so that all students have the opportunity to practice invention skills. This process may be initiated by learning about inventors and inventions, providing an appreciation for past and present inventions, and enhancing an anticipation of future events.

Learning About Inventors: By learning about inventors and their inventions, students should develop a historical perspective on the impact of science and technology. They should know that successful inventors:

- have open and curious minds.

- acquire as much information as possible about an idea, problem, or future invention before actually putting a product together or coming up with an idea.
- often try many times before ending up with the desired product or idea.
- try to improve on the idea or design after finding a solution.

One of the goals of this part of an STS curriculum should be to change the students' image of "inventor." Most inventors do not fit the commonly held misconception of the absent-minded, wild-haired, mad inventors in a laboratory filled with bubbling, gas-filled test tubes.

Finding the Idea, Challenge to the Imagination: All inventions begin with an idea. Everyone has good ideas, but most people are not in the habit of pursuing them in ways that lead to marketable products. The activities listed below tend to promote inventive thinking and facilitate finding ideas:

Brainstorming

Brainstorming is a group method of generating a large base of ideas. A problem is presented and the group generates as many ideas as possible.

Attributing

Attributing is the process of observing and describing the characteristics of things. This process is basic to examining factors which may influence problems and their solutions.

Associating

Associating implies examining things from different perspectives. This is the process of "making the strange familiar and the familiar strange."

Building up Alternatives

Effective alternative building rests on a foundation of attributing and associating skills. By using patterns and processes in a variety of perspectives, the inventor can restructure or rearrange ideas to create new ideas.

Synthesizing

Synthesizing is a combining process; something is placed with something else and a new entity is produced.

Visualizing

Visualizing refers to mental images. We often can "see" things in our mind's eye. These images may be difficult to put into words.

Think Drawings

Think drawings may form important representations of things we visualize. These drawings are distinct from art forms in that the quality of the drawing is best measured by the way an idea or function is pictured, not how aesthetically pleasing the depiction is.

Part Changing

In part changing, an existing object or phenomenon is altered by changing one or more components. This skill could include reversing (trying opposite approaches).

Questioning for Clarification

Asking the right questions may generate new ideas. The person asking the questions should avoid judging, moralizing, and criticizing.

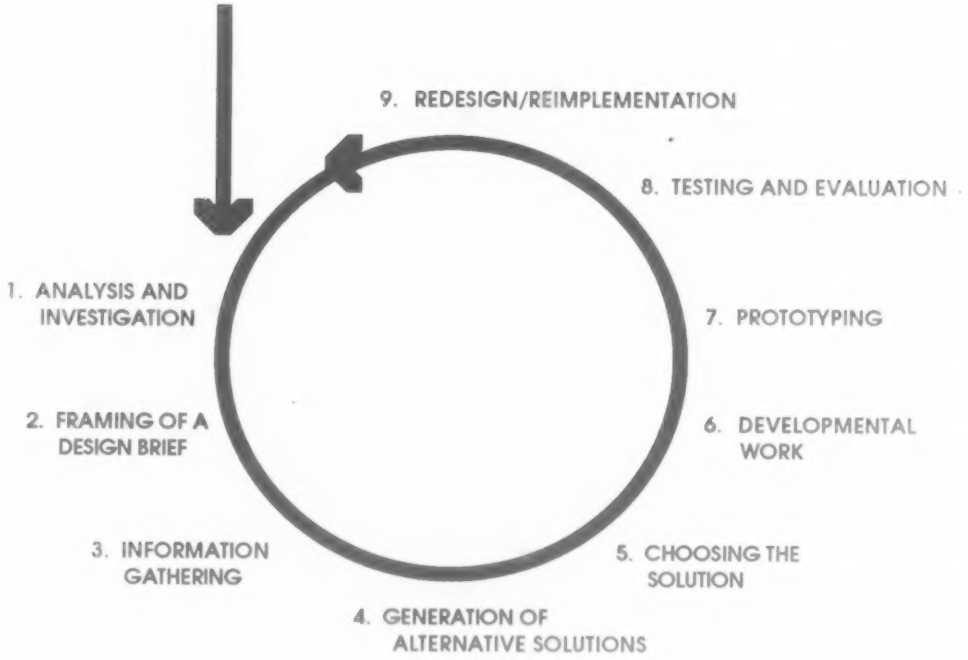
Incubation and/or Planning: Ideas generated in the challenge to the imagination stage initiate the incubation and/or planning component of the creative process. Eventually the idea needs to be transformed into a verbal or written statement. This statement then becomes the basis for an extended thinking-planning process. Some good ideas may incubate in the back of the mind for days, weeks, or even years. The incubation part of the total process is very important. Research indicates that even seconds of wait-time makes a difference in student response in questioning situations. In this stage of creativity we are talking about much longer times.

The incubation stage normally is not all mental process. It may include drawings, journal entries, and even experiments. The end product of this stage is the detailed plan for an invention.

Do It: The working plan from the incubation and/or planning stage becomes the basis of physically creating what has been mentally planned. The resulting product may be thought of as a prototype.

Evaluation: The prototype must be evaluated. This is the point of transition to *technology as design* that follows.

Technology as Design: One of the key concepts appearing in the literature of technology education is "design." Generally, this concept is associated with technology as process. In STS curriculum, the student should function as a decision maker in the technology process, as a designer, engineer, fabricator, controller, evaluator, and consumer. The "design loop" (New Jersey Department of Education, 1987) provides a model for this component of STS education.


9. REDESIGN/REIMPLEMENTATION
8. TESTING AND EVALUATION
1. ANALYSIS AND INVESTIGATION
7. PROTOTYPING
2. FRAMING OF A DESIGN BRIEF
6. DEVELOPMENTAL WORK
3. INFORMATION GATHERING
5. CHOOSING THE SOLUTION
4. GENERATION OF ALTERNATIVE SOLUTIONS

Analysis and Investigation of a Real-World Situation: This process should logically start with a critical examination of a real-world situation to determine the presence and nature of a problem.

Framing of a Design Brief: A statement describing what a solution to the problem should do and what constraints are being imposed as necessary to keep the process on track. Various issues of TIES (Technology, Innovation, and Entrepreneurship for Students, Drexel University, Philadelphia, PA) are good sources of design briefs.

Information: Before attempting to develop solutions, the designer (student) must become familiar with the influencing factors associated with the problem. What attempts have others made to solve this problem? What are the sizes, stresses, loads, power requirements, appearances, and economic factors involved? These are some of the sub-problems which must be addressed if viable solutions are to be found.

Generation of Alternate Solutions: If this were a mathematical or scientific problem, only one answer would probably be correct. But in a technological problem, there are no right or wrong answers, only good and bad solutions. To arrive at a good solution, the designer will need to look at many alternatives. Students will probably find this the most challenging step in the process, calling for originality and flexibility.

Choosing the Solution: From the alternative solutions developed, the student must choose one which best satisfies the demands of the situation and the design brief. He/she should be able to defend the choice with reference to each requirement of the situation and brief.

Developmental Work: (drawings, evolutionary models, simulations, etc.) This step may manifest itself in the form of a device, computer simulation, a series of graphic sketches, or a model made of flexible materials. The design brief and initial problem/need will specify the final outcome of this step. Often the student will make various models before making an operational device. Appearance may not be very important at this stage. Appearance takes on more importance after testing and evaluation have confirmed that the solution chosen meets the specified requirements. Developmental work also includes technical planning of procedures and resource management.

Prototyping: This is the actual construction/realization step of the process. Appearance is more important here, but only so far as the need to "sell" the idea or product. After the device is tested and revised, the prototype may be "finished" for final demonstration. The device or product should be operational and quality work should be in evidence.

Testing and Evaluation: The solution should always be evaluated against the requirements established in the design brief, and against the original problem statement. Testing the solution to see if it handles the load, operates correctly, meets appearance requirements, is reliable, and solves the problem, is an important part of the design process. Evaluating the result should address the need for improvements, changes, etc.

Redesign/Reimplementation: The evaluated and tested solution may be re-worked and re-tested. This is especially important if the product is to be produced in any quantity or if it is to be put into actual use to solve a real-life problem. At this stage, the appearance of the product takes on more importance. Even if the product isn't taken to real-world application, consideration should be given to how the solution would (or does) "change the world." Such consideration "closes the loop," reinforcing the nature of design, as suggested by the model, and provides a forum for considering the concept of "impacts."

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Environmental literacy in science education
Experiences from a Dutch curriculum development project

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1. Introduction

"Our Common Future", the Brundtland report on environment and development, emphasizes the importance of environmental literacy: The transition to a sustainable development will require complex and difficult choices, which can be made only with support of a well-informed public. This importance is acknowledged in the Netherlands, where "the environment" has become a political top-priority and even caused a political crisis recently. A result is an increasing support for environmental education. The Project on Environmental Education in Secondary Education (Dutch acronym: NME-VO) was the start of an extensive effort to implement environmental education in the educational system. The project NME-VO ran from 1986 untill august 1989 and developed a curriculum-document and teaching materials on environmental education for the school-subjects science and geography.
This paper describes

- Some features of environmental education, as chosen by the project. What is environmental education about? Which are the core-concepts? Should students be informed about the environment or be turned into environmentalists? How could environmental literacy be integrated in science education?
- The social and political context of the implementation of environmental education in the Netherlands.

The results of the NME-VO project, with regard to learning-effects and outcomes of research into students' conceptions, are reviewed in another paper for this conference (De Jager 1990).

2. The project NME-VO

The project NME-VO (figure 1) was a joint activity of environmental NGO's, educational organisations and some trial-schools and was financed by the government. The main aim of the project was to integrate environmental education in the subjects biology, chemistry, geography and physics at all ability levels of secondary education (science is split up in separate subjects in junior and higher

THE PROJECT NME-VO :

- means Environmental Education in Secondary Education
- is a cooperation between environmental NGO's and educational institutions, schools
- is financed by the Departments of Education, Agriculture and Environment
- integrates EE in biology, physics, chemistry, geography
- for K7 - K9/10, all ability levels
- activities:
  - development of a curriculum on EE
  - development of teaching materials
  - research on students' conceptions and learning effects
  - try-out in 9 trial-schools
  - implementation acivities

figure 1
Some features of the project NME-VO

secondary school). The scope of the project was confined to these schoolsubjects for rather pragmatic reasons. Experience existed with developing a science curriculum in technological and social context. The environment can be one of these contexts (Kortland 1987). The combination of science with geography could broaden the scope of environmental education .
The main activity was the development of a curriculum-document for environmental education in junior science and geography education (Pieters 1988, 1989) and several teaching-units (figure 2). The quality of these materials was improved by the classroom-experiences from 9 trial-schools and by research on students' conceptions and learning effects (de Jager 1987, 1989). Both the primary development and the revision of the materials was done in co-operation with the trial-school' teachers.

title	topics	subjects	form	age group	ability level
wetlands	human use of wetland	ge/bl	1	12-13	all levels
meat	environmental effects and alternatives of meat production	ge/bl	2	13-14	all levels
fuel	local contributions to solving the energy (fuel) problem	ch/ph/ge	3	14-15	high
traffic noise	traffic noise and ways of reducing hindrance	bl/ph/ge	3	14-15	average
pesticides	environmental effects of pesticides, and alternatives	bl/ge	3	14-15	low
waste management	compare different ways of waste disposal on environmental effects	bl/ch/ph/ge	4	15-16	high
handbook NME-VO	miscellaneous	bl/ch/ph/ge	1-3	12-15	variable

figure 2
The NME-VO teaching-units

3. Structure of the NME-VO teaching units

Environmental problems are mostly complex and need a multidisciplinary analysis and policy. So environmental education requires contributions from different school-disciplines. On the other hand the Dutch school-organisation is based on separate subjects. Even science in junior education is split up in biology, chemistry and physics in most schools. Co-operation between teachers from different disciplines is not easily realized in practice. Teaching materials for each separate discipline would be most easy to implement. However this co-operation was an important motivation of the schools participating in the project NME-VO.
The project NME-VO has solved this dilemma as follows. Each teaching unit has been designed for 2-4 schoolsubjects and focusses on an environmental issue (figure 3). It has a orientation and a conclusive part, which are not specific for any subject and are related to the environmental issue. They can be taught in each subject. However, besides these general parts a unit has separate parts for each schoolsubject. The optional part is specific for each subject in some units , but in other it is mainly related to the issue.
This structure will be illustrated with the unit "Meat".

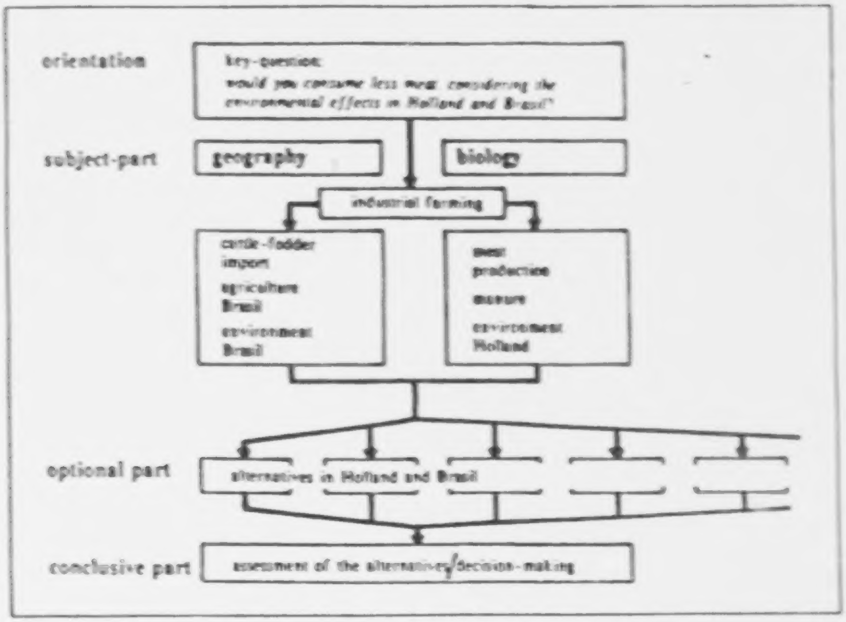

orientation
key-question:
would you consume less meat considering the environmental effects in Holland and Brasil?
subject-part
geography
biology
industrial farming
cattle-fodder import
agriculture Brasil
environment Brasil
meat production
manure
environment Holland
optional part
alternatives in Holland and Brasil
conclusive part
assessment of the alternatives/decision-making

figure 3
The structure of the NME-VO unit "Meat"

Meat
The unit "Meat" deals with the meat consumption and production, related to the environmental problems at home (manure, acidification) and in Brasil, from where much cattle-fodder is imported. In the orientation the environmental issue is introduced. The introduction ends up with a key-question, which will structure the content of the unit. "Would you consume less meat considering the environmental effects?" is the key-question in "Meat". The subject parts deal with aspects of the environmental problem and possible alternatives: biology focusses on manure and acidification in Holland, geography on deforestation and erosion in Brasil. In the optional part students examine different alternatives, as dehydrating the manure, stripcropping or vegetarian meals. Do they provide a solution? Which are the consequences? In the conclusive part the alternatives are valuated and the key question is answered.

In the subject parts basic knowledge, useful to understand the environmental problem well, is provided by texts or gathered by fieldwork or classroom-experiments. This solves another dilemma of environmental education. Environmental education should be paid attention to in school, but it is not a separate subject on the timetable. So many teachers consider environmental education as an extra item, for which they cannot find much spare time. Therefore the NME-VO aim was to integrate environmental education in the regular school-subjects. This is achieved by teaching concepts from the regular syllabi in the context of the environmental issue, especially in the subject parts (Kortland 1987). Factory-farming, erosion, the food-chain, the relation between agriculture and acidification are concepts from the geography and biology syllabus.

This unit-structure has proved to work well in practice. Although in some schools even this extent of co-operation between teachers from different disciplines was hard to realize, most schools were very positive about working this way. It even encouraged the teachers' enthiousiasm to co-operate (Pieters 1988).

4. The relation between man and environment

Wetlands, meat, fuel, noise, pesticides, waste. These topics represent very different issues in the students' view, but we call them all environmental issues. Should students learn a lot about various different environmental issues or should they develop a general conceptual framework? Should environmental education have a systematic approach or deal with specific environmental issues? In answer to this dilemma the project NME-VO has made the choice to develop units based on specific issues. However, a conceptual framework has been developed to describe and analyse these various issues in a coherent way.

Environmental education deals with the relation between man and environment, the problems in this relation and possible solutions. Figure 4 shows the conceptual model that is used in the NME-VO teaching materials in respect of the relation between man and environment. The environment has various significances for man: it has a significance for his health and safety, it can be used for economic purposes and man can attribute an intrinsic value to the environment, apart from any use. On the other hand man intervenes in the physical environment: he extracts matter and energy from the environment (for instance food), he adds these also (for instance waste), and he changes the information of the environment (for instance by constructing a road in a landscape). Man makes these interventions in the environment, because he decides to do so. And his decisions are based on societal goals and human values.

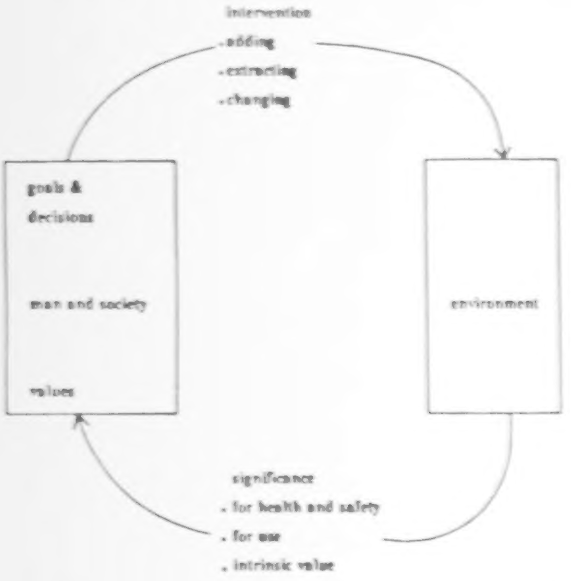


Figure 4
A conceptual framework for the relation man-environment

The human interventions can have positive and negative effects. Environmental problems arise if the intensifying human interventions affect the meanings of the environment for man. Extraction leads to depletion, addition to pollution and change to deterioration. Depletion, pollution and deterioration are value-bound concepts, because they express that negative appreciation of the human interventions. This negative valuation is related to the premiss of a sustainable development of the relation between man and environment. In a sustainable development the significances of the physical environment for man should be preserved and no negative effects should be shifted off to people elsewhere or to future generations. Summarizing, a number of core-concepts for environmental education are identified as a conceptual frame-work (figure 5). This framework is (implicitly) applied in all units, although most concepts are used explicitly. As a summary, a unit from the Handbook deals with the conceptual framework explicitly. The framework will be illustrated with the unit "Wetlands" (Brunsting 1989).

- sustainable development
- (physical) environment
- significances of the environment: *health/safety, economic use, intrinsic value*
- human interventions: *extraction, addition, change*
- choices/decisions
- shifting off
- environmental problems: *depletion, pollution, deterioration*
- solutions

figure 5
Core-concepts for environmental education

Wetlands

The unit "Wetlands" focusses on the sustainable co-existence of men, animals and plants in one area. Typical ecosystems exist in the wetlands and man is part of these systems. However, his interventions increasingly threaten the wetlands' significance for animal and plants. The preservation of wetlands is an important national and global issue.

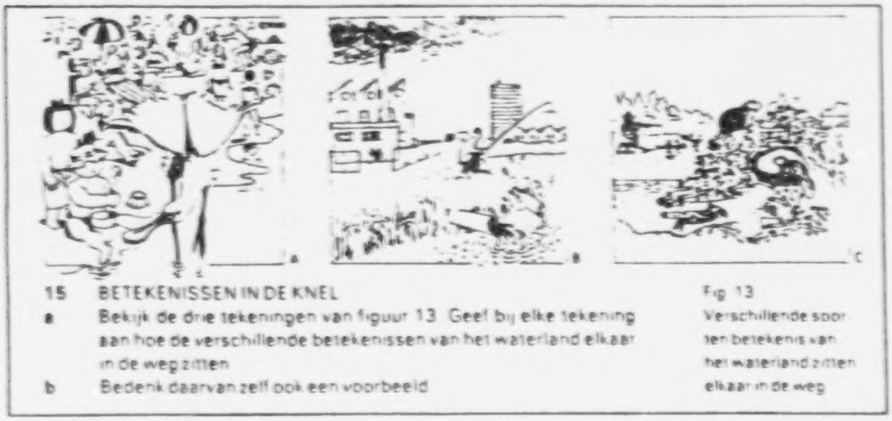
In the orientation the concept of wetland and the key-question "Is there room for both men, and animals and plants in wetlands?" is briefly introduced. The major part of the introduction is devoted to fieldwork in a nearby wetland. Outdoor student-activities aim at a concrete introduction to the various aspects of wetlands and to more awareness of the wetlands' significances. The results of the fieldwork-activities are frequently referred to in the subjects parts.

The subject parts for biology and geography provide information on the wetlands' significances and the interaction with human activities. The biology part pays attention to the adaptations of plants and animals to wetlands. It is shown how the adaptations are functional in the wetlands, but also how they increase the dependence of the species on their environment and make them more vulnerable. Information about foodchains and foodwebs shows the dependence of species on each other. From this the students get an idea about the ecology of wetlands and its intrinsic value. Moreover, the wetlands provide us with natural supplies of fish and clean water, as the ecosystem of micro-organisms, plants and animals has a nursery-function for fish and a capacity of self-purification. Human interventions could disturb the ecology of the wetlands and endanger their functions for man.

The geography part deals with the human settlement in the wetlands, in former days and now, and the changes which resulted from this settlement. It is illustrated that man uses the wetlands for various ends: settlement, transport, resources of thatch, gravel and drinking-water. It is shown that these interventions could cause dehydration or pollution of the wetlands.

In the optional and the conclusive part students analyse the significances of a national wetland-area (Wadden-sea) and design a management plan for this area, considering the conservation or the wise use of the environment as possible policies.

In this way the significances of wetlands for man and the ways man intervenes in the wetlands are developed from ecological and geographical point of view. Research into students' conceptions made clear that their idea about (the significances of) wetlands becomes more complete. At the outset pupils tended to consider wetlands merely as a living place for plants and animals. After the unit on wetlands they were better aware of the role of man in the ecosystem and of the problems which threaten wetlands.



15 BETEKENISSEN IN DE KNEL

a Bekijk de drie tekeningen van figuur 13. Geef bij elke tekening aan hoe de verschillende betekenissen van het waterland elkaar in de weg zitten

b Bedenk daarvan zelf ook een voorbeeld

Fig 13
Verschillende soorten betekenis van het waterland zitten elkaar in de weg

figure 6
Introduction of the core-concept "significance" in "Wetlands"

5. Decision-making
The aims of science education are broadened towards enabling students to cope with problems in everyday-life. In this context decision-making is considered as an important skill for science education (Watson 1980, Aikenhead 1983, Eijkelhof 1987). This applies also to environmental education (Zoller 1982, de Jager 1989). Environmental education aims at enabling students to take environmental effects into account in their behaviour and opinions. Therefore, it is not sufficient to know a lot about the environment, neither about environmental problems. The environmental conceptual framework should be taught in a decision-making context. However, it is not easy to translate decision making into manageable teaching materials (Zoller 1987, de Vries 1987). As an answer to the dilemma the NME-VO project has developed a decision-making procedure, represented by the flow-chart in figure 7 (Pieters, 1989). This scheme is used in the teaching materials (Kortland 1988), as can be illustrated with the unit "Waste management" (Brunsting 1989). Some experiences on the way students take decisions and on the development of the decision-making skill are described by de Jager (1990) in another paper for this conference.

Waste Management
The unit "Waste management" deals with (various aspects) of the waste problem and with 4 methods of waste-management. In the unit an Environmental Impact Assessment procedure is followed. Students are asked to evaluate the 4 methods and finally to choose their preference in respect to the key question. This unit's key-question is formulated as "What is the best way to manage domestic waste?". As in each unit, the key question reflects a decision to be made.

The decision-making scheme (figure 7) has been implemented in the unit Waste-management as follows. After the orientation has introduced the waste problem, the 4 methods of waste management and the key question, the subject-parts (for biology, chemistry, geography and physics) give information about aspects of the waste problem and about the alternatives. In order to make a deliberate decision the waste-problem has to be well understood. And again, this requires much

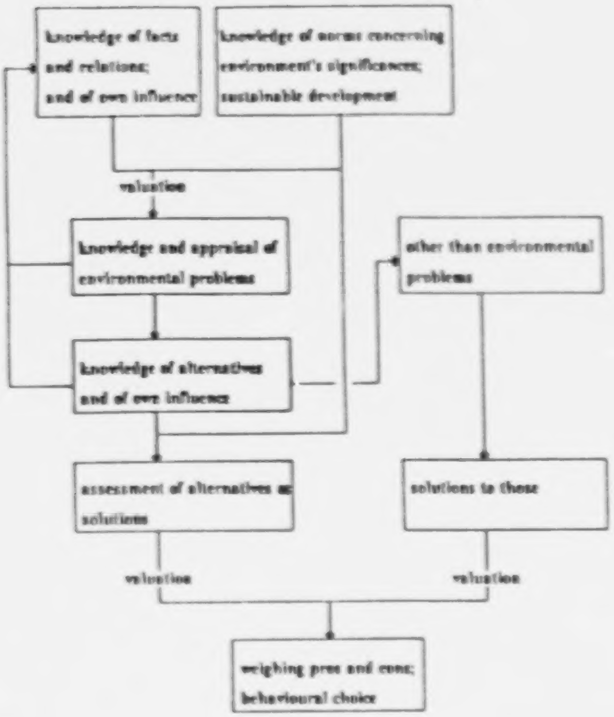

knowledge of facts and relations; and of own influence
knowledge of norms concerning environment's significances; sustainable development
valuation
knowledge and appraisal of environmental problems
other than environmental problems
knowledge of alternatives and of own influence
assessment of alternatives as solutions
solutions to those
valuation
valuation
weighing pros and cons; behavioural choice

figure 7
The NME-VO decision-making flow-chart

fundamental knowledge (for instance about heavy metals, composting, energy-use). Analyzing the problem gives lead to the formulation of criteria for sustainable development: less risk of pollution, less consumption (depletion) of mineral resources and fuel, less deterioration of landscape, flora and fauna. Confrontation of the knowledge about the real situation and these norms for sustainable development present a main moment of valuation: how serious do you consider this environmental problem? Many decision-making schemes (Brim 1962, Woodley 1977) formulate this stage explicitly: to identify a decision-making situation and to recognize the need to make a decision and to take action is a first, but crucial step.

In the optional part students analyze an Environmental Impact Statement about the 4 alternatives in a fictitious country. They make an assessment of the 4 alternatives of waste management (landfill, combustion, central separation and source separation). That means, they assess in which respect and to which extent each alternative is a real solution for the environmental problems. They do not yet define a preference to one of the alternatives. The assessment is done in respect to 12 criteria (figure 8), most of them reflecting the criteria for sustainable development. But also other criteria, derived from other problems, like costs, employement and convenience, are taken into consideration. Each alternative gets a mark for each of the 12 criteria.

How do you judge a waste management alternative, if you take into account:	landfill	burning	central separation	source separation
depletion				
1. depeltion of mineral resources				
2. depletion of energy resources				
3. depletion of forest resources				
4. depletion of soil fertility				
pollution				
5. effects of pollution on flora and fauna				
6. effects of pollution on human health				
7. effects of pollution on land use				
affection				
8. effect of occupation of area and disturbance on flora and fauna				
9. effect of occupation of area and disturbance on land use				
other considerations				
10. costs and benefits				
11. employment				
12. convenience to inhabitants				

figure 8
Assessment-matrix in the unit "Waste-management"

In the final part a role play presents a opportunity to define a preference in respect to the 4 methods of waste-management. Now the 12 criteria must be valued in respect to each other. Depletion of mineral resources against pollution, deterioration of flora and fauna against costs or employement. This presents another main moment of valuation: which alternative would you prefer? Here, knowledge and values are mixed up to answer the key question.
It is argued that a next important step in decision-making is to make an action-plan and to adhere to the decision made (Woodley 1977, Zoller 1987, Aikenhead 1988). Nevertheless, this stage is left out from the NME-VO teaching materials. In our view it is up to the teacher to extend the decision-making with (the planning) of actiontaking, rather than structuring this in the teaching materials. The teacher-guide presents some suggestions in this respect.

6. The goal of environmental education

Much could be said about the goals for environmental education. Many different views exist. Should environmental education seek to turn students into environmentalists or should it be restricted to information about the environment? Many environmental educators propagate the first option.
However, the project NME-VO takes a more moderate position in this dilemma. Of course, the social context of environmental education is the need that the younger generation will develop a more "sustainable" behaviour, and the hope that environmental education will contribute to that. But that is at best a long-term goal for environmental education, not a concrete educational objective (Boersma 1989). There are at least two sets of constraints for such a far-reaching goal, moral and practical. From moral point of view, education should not propagate one specific

behaviour. In a democratic society students should make their own decisions. Education can provide the students with the knowledge and skills to act in correspondence with a sustainable development, but they should draw their own conclusions. Moreover, propaganda for one specific behaviour will work out contraproductive with modern emancipated students.
But there are also practical constraints. Even if one would change the students' behaviour, the possibility to do so via education would be limited. Many out-of-school factors, as the student's social context, determine the actual behaviour. A limited number of lessons on environmental education will not change the world. One should not formulate too idealistic objectives for environmental education.

The project NME-VO formulates the aim for environmental education as:
"Students are enabled to take a sustainable development of the relation between man and environment into consideration in their behaviour en opinions".
This aim is worked out into 6 goals for environmental education (figure 9). These are based on a broad consensus among environmental educators in The Netherlands (Boersma 1989).

relation man-environment
1. students acquire knowledge and insight in the material and immaterial meaning of the physical environment to people, on an individual level and a social level;
2. students acquire knowledge and insight in man's impact on the physical environment as an individual as well as related to society.

environmental problems and their causes
3. students acquire knowledge and an insight in relation man-environment to a few relevant environmental problems;
4. students acquire knowledge and an insight in background and cases of these problems.

solutions
5. students acquire an insight in the conditions for solutions of some relevant problems from the perspective of a sustainable and healthy relation man-environment;
6. students acquire an insight in possibilities and limitations of certain solutions to these problems, and in the role that an individual can play in these solutions.

Figure 9
Goals for environmental education

The emphasis is on knowledge and skills. Environmental education can provide students with the instruments to act according a sustainable development or to take an environmentally aware position. These instruments can be evaluated as the outcome of the educational process. If students actually use these instruments and (decide to) act "sustainably" in practice is up to them and not to be evaluated in school.
Nevertheless, the NME-VO teaching materials are not only about knowledge and skills. Affective aspects and moments of valuation are essential for environmental education. The units present various learning situations, which might stimulate students to develop an opinion or behaviour of their own. Fieldwork, classroom experiments, classroom discussions, group-activities, role-play, interviews are frequently used as student's activities. These promote valuation in an open way, in relation to the 2 main valuation-moments, as described in the preceding section: a. how serious do you consider the problem; b. which alternative would you prefer?

The information in the NME-VO units is open-ended to this second question, but not neutral to the first one. The information emphasizes that there are serious environmental problems, but shows both the positive and negative consequences of alternatives.

Teachers from the trial-schools reported that assimilation of these goals takes time. During the first try-out they had to cope with new texts and experiments and this made their orientation rather cognitive. Gradually their attention and interest shifted towards the affective aspects of the units and they put a greater emphasis on the valuation-moments in the classroom. A continuous interaction between teachers and curriculum developers stimulated this development in orientation.

7. The (political) process of implementation

In the near future all students in Dutch secondary school will be involved in environmental education in various schoolsubjects. So the implementation of environmental education in secondary education is on its way. How did efforts to achieve this become succesful?

Three developments are important in this respect.
a. "The environment" has become a political priority. From 1970 onwards the discussion on environmental issues has intensified. The Ministry of Environment was established in 1971 and environmental policy was developed. Still, the symptoms of the bad state of the natural environment became increasingly visible and the environmental awareness increased. Since the publication of an official report on the state of the environment (Concern for Tomorrow 1988) the environment has become a political priority. A National Environmental Policy Plan (1989) based on this report even caused a political crisis.
Since many years environmental education is considered as one of the official policy instruments, as it might increase the public support for environmental policy.
b. A strong network of environmental (non-governmental) organisations has been developed, partly financed by the government. The main functions of this network are to influence governmental environmental policy and to promote and practise environmental education, both inside and out of school. The organisations started to develop teaching materials on environmental issues and gradually penetrated the school system. Besides, the organisations generated a political lobby on environmental education. A relations-network with Members of Parliament and civil servants has been created and proves to be of great value.
c. In science education a development towards STS-education takes place. A major impetus to this development was given by the PLON-project on physics education. This project developed a physics curriculum consisting of thematic units, in which physics is taught in a technological and social context. Gradually the idea of teaching science in a wider context is accepted (Eijkelhof 1987).
From this point of view environmental issues can be considered as a context of science education (Kortland 1987).

These three developments came together in 1985 and gave birth to the project NME-VO. The environmental organisations had experience in developing teaching materials on environmental issues and looked for implementation in secondary education to a larger extent. The PLON-project and the National Institute for Curriculum Development had experience with the development of science teaching materials in a broad context. And Departments were willing to spend money on environmental education.
During the project NME-VO the co-operation between these institutions intensified and the institutional platform for environmental education was strengthened.
In the meantime a document on environmental education was prepared by the Departments of Environment, Agriculture and Education and discussed in Parliament

in 1987. Influenced by the political lobby of the environmental NGO's, an outcome of this discussion was that more Departments should pay attention and money to environmental education. This decision might increase the budget for environmental education in the next years significantly. Moreover, the National Environmental Policy Plan (1989) emphasizes environmental education as one of the main strategies towards a sustainable society.

Another development in favour of the implementation of environmental education is the reconstruction of junior secondary education (12-15 year) towards a single national curriculum. In 1986 committees were formed to formulate statements of attainment for each school subject. The NGO's political lobby achieved that several committees got an instruction to include environmental aspects in the statements of attainment. In the meanwhile a blueprint for statements of environmental attainment was formulated by the NME-VO organisations. By membership of these committees and/or by reviewing their drafts the NGO's and the project NME-VO have effectuated that the statements of attainment, as formulated for the subjects biology, physics/chemistry, technics, geography, history and economics, actually pay attention to environmental aspects.

The project NME-VO has finished. However, new activities to develop and implement environmental education have started. They have a broader scope than the NME-VO project: a broader set schoolsubjects in secondary education; not only secondary education, but also primary education and vocational training; more different implementation-activities; an extended network of organisations.
A Minister of Environment once stated: "The public policy might be more in favour of a sustainable environment as the public is more aware of the environment". This environmental awareness is on its way in Dutch schools!

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TOWARD THE TWENTY-FIRST CENTURY: PROBLEM SOLVING THROUGH SCIENCE, TECHNOLOGY AND SOCIETY FOR A MIDDLE-LEVEL SCIENCE CURRICULUM

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The New York Science, Technology and Society Education Project (NYSTEP) is a joint effort of the Atmospheric Sciences Research Center at the State University of New York at Albany (SUNY-A), the Bureau of Science Education of the New York State Education Department (NYSED), and the electric and natural gas companies of New York State. These three organizations have a unique programmatic and organizational relationship known as the New York Science, Technology and Society Project (NYSTEP) and have worked together in contractual partnership since 1982. This partnership has developed award-winning elementary and secondary school energy education curricula, and provided staff development training in their use to New York State teachers as a component of dissemination.

The NYSTEP, whose most recent recognition award is from the National Association for Industry-Education Cooperation (September, 1988), now has proposed to enhance the scientific literacy of middle-level (grades 7-9) students and to assure appropriate participation of underrepresented minorities and females in science and science education.

Over a four-year period, twelve Science, Technology and Society (STS) modules are being developed and field-tested by NYSTEP using National Science Foundation funds. The NYSED is using State funds to revise concurrently the middle-level science syllabus and the Regents Competency Test in Science so that both match the proposed modules. The modules will then be disseminated statewide by NYSTEP's forty Resource Agents who will perform staff development activities for middle-level science teachers using funds provided by the New York Power Pool and the New York State Education Department.

ACTIVITIES

> The curricular materials under development are twelve middle-level science modules that emphasize problem solving and decision-making through Science, Technology and Society (STS) issues. In order to maximize the use of these modules, the New York State Education Department (NYSED) is funding, for concurrent and parallel development, major revisions of the middle-level New York State science syllabus and the New York State Regents Competency Test in science for grades 7-9. In effect, changes in all three components -- the programmatic curriculum modules, the syllabus (with its intended learning outcomes), and the testing program -- complement each other and increase the likelihood of appropriate use of each by the approximately 5,000 middle-level science teachers and 600,000 middle-level students in New York State.
>
> The other set of ongoing activities relates to providing staff development for the middle-level science teachers to whom the modules will be disseminated. This set of activities is funded by cost-sharing through sources other than the National Science Foundation (NSF). Interwoven staff development networks already in place bring appropriate awareness and training to science teachers and supervisors. This training is expected to result in major instructional style changes for science education as it takes place in middle-level science classrooms of the future.

Pre-award Activities

Three organizations joined together in 1982 to develop and disseminate energy education materials in New York State -- the Atmospheric Sciences Research Center at the State University of New York at Albany (SUNY-A); the Bureau of Science Education of the State Education Department of New York State (NYSED); and the New York Power Pool (NYPP), a private sector association of investor-owned utilities and the New York Power Authority. These partners sought and obtained funding from the NSF to share costs as project emphasis was broadened from energy education to Science, Technology and Society (STS) education. Accordingly, the name of this organizational relationship was changed to the New York Science, Technology and Society Project (NYSTEP).

During the pre-award period the following middle-level science education activities were conducted by NYSTEP in conjunction with outside consultants and NYSED Bureau of Science Education staff members:

1. Completion of a statewide needs assessment involving middle-level science teachers and administrators.
2. Completion of a review of the literature on the nature of middle-level students, science education, and Science, Technology and Society (STS) education.
3. Formation of and initial meetings of an advisory committee composed of private and public sector scientists, and pre-college and college educators.
4. Completion of an outline of a new middle-level science syllabus (framework) for New York State.
5. Production of a prototype STS module in solid waste management to serve as the model for development of twelve additional middle-level science modules.

During the summer of 1988 NYSTEP began to prepare for change. Project plans were presented and refined at a summer institute held to reorient the educators comprising the NYSTEP statewide network for staff development, which includes forty resource agents and ten private sector utility educational representatives.

Also, during the summer of 1988, two middle-level science teacher/consultants worked twenty days each with NYSTEP and NYSED staff drafting a needs assessment instrument, conducting a literature review, and developing working documents and recommendations for the project's advisory committee to be convened in Albany, New York during the winter of 1988-1989. The project advisory committee members are:

o Estella Abel	Supervisor and Teacher, Mount Vernon High School
o Kathaleen Burke	Teacher, Buffalo Magnet School
o John Cafarella	Supervisor, SCD 10, NYC
o Michelle Cambier	Bilingual Supervisor, NYC Board of Education
o Audrey Champagne	Scientist, AAAS
o Kenneth Male	Scientist, Capital Region Technology Development Council
o Michael Pisterzi	Engineer, IBM
o Conrad Toepfer	Educator, SUNY Buffalo
o Nancy Van Branken	Teacher, St. Bernard's School
o Theodore Bredderman	Educator, SUNY Albany

The NYSTEP Staff are:

o Caroline Graham	Project Director
o William Peruzzi	Coordinator
o Dennis Cheek	Coordinator of Curriculum Development
o Lesa Clark	Administrative Assistant
o Maxine Ballard	Secretary

NSF AWARD ACTIVITIES

A. Development of middle-level science modules.

The curricular modules under development through NYSTEP are intended for all middle-level students. The process of development assures that the modules are particularly appropriate for use by females and minority students, traditionally underrepresented in scientifically and technically based jobs.

In the 1986/87 school year, black, Hispanic, and other minority students accounted for 37.5% of the student population in New York State. For the "Big Five" urban centers -- Buffalo, New York City, Rochester, Syracuse, and Yonkers -- minority students accounted for 74.6% of the school population. The NYSED has developed a comprehensive, long-term policy and implementation strategy for educating at-risk children and youth and for ensuring that schools have the necessary resources and assistance to meet the challenges of economically disadvantaged students. The NYSTEP staff seeks to support those efforts. The initial materials development activities of this proposal have taken place in the urban settings of the "Big Five" cities. Readily available minority student target audiences, programs intended to provide support for at-risk students, and personnel experienced in urban setting teaching have actively supported the development and refinement of appropriate curricular materials.

The NYSTEP STS modules developed thus far are:

- Solid Waste Management (Pilot Test Edition)
- Human Health Sciences (Draft Edition)
- The Future (Draft Edition)
- Water Resources (Draft Edition)
- Land Use (Draft Edition)

Modules to be developed during the summer of 1991 are Natural Disasters, Transportation, Communication, and Wildlife.

The NYSTEP Resource Agents are from various geographical locations statewide. They help conduct further field-testing of the curricular products in contrasting settings (urban, suburban, rural), so that the proposed modules will be applicable statewide.

National Science Foundation (NSF) funds have been used to hire a NYSTEP coordinator of curriculum development who supervises the four curriculum production teams, one each from the "Big Five" cities (only 4 cities participate in a given year). Each team consists of two teacher writers, two private sector scientist writers/consultants, underrepresented minority students who serve as curriculum development advisors, and underrepresented minority teacher(s) in training who supervise the student advisors and also serve as local curriculum development advisors.

The eight teacher writers were trained in STS and in curriculum writing by NYSTEP and NYSED staff and scientists and consultants at a summer institute. Private sector scientists were recruited from each of the "Big Five" cities, and they became active members of their curriculum production teams as writer participants as well as consultants. The advisory role for the underrepresented minority students and the one or more teachers-in-training on each curriculum development team included participating in pre-writing activities such as literature searches, reading drafts for face validity, pilot-testing the "hands-on" and "minds-on" activities produced, and making suggestions for improvement based upon their experiences and viewpoints.

The science directors for the "Big Five" cities hosted the curriculum production teams and served as non-paid liaison persons to the NYSTEP project. Each director worked with the NYSTEP staff to identify and recruit the middle-level teachers who served as paid curriculum writers. Each director located physical sites within his or her school district where curriculum development teams met and curriculum development took place.

The science directors (and NYSTEP staff) have seen that:

1. For each year, their writing team has two science teachers from grade 7, 8 or 9, at least one of whom is a female and/or underrepresented minority group member.

2. Their writing team has at least two paid secondary school student advisors and at least one teacher-in-training advisor(s) all of whom are members of underrepresented minority groups, and of whom at least 50% shall be females. (Advisors are paid through New York State's legislatively-funded Science and Technology Entry Program (STEP) using Structured Education Support Program (SESP) funds and Teacher Opportunity Corp (TOC) funds, all of which are administered by NYSED).

Each curriculum development team used an "adopt and adapt" procedure to produce instructional activities. Each team, during the first summer assembled activities into a middle-level science module, in draft form ready for pilot testing and will continue to do so for the next two years of the project. That production level is intended to produce a total of twelve modules -- four for grade 7, four for grade 8, and four for grade 9. The NYSTEP staff has made periodic on-site visits to help the curriculum development teams as work proceeds.

B. Staff development activities.

Before educational materials are used in the classroom, they must gain the attention of teachers, supervisors and administrators. Moreover, faced with competing demands and limited time, all must be convinced that the materials are significant, of high quality, and easy to use. In order to effectively introduce the proposed middle-level science modules, the project makes use of its own and two other professional staff development networks in the state, all of which follow the "teachers learning from teachers model". Each of these networks has been a highly effective way of involving teachers in staff development activities:

(1) The NYSTEP network is composed of forty resource agents (typically classroom teachers) and ten private sector NYPP Educational Representatives who together developed and conducted teacher workshop activities while disseminating energy education booklets. This network has continued to be maintained through private sector NYPP funding as the proposed middle-level modules are being developed. Staff development activities by resource agents include conducting workshops, inservice courses, and summer institutes; providing technical assistance to local school staff; and encouraging other educational activities such as local curriculum development.

(2) The Teacher Resource and Computer Training Centers, 101 statewide, are legislatively funded and administered through NYSED. Each is operated by independent boards, on which most members are precollege teachers. Included in the Teacher Center mandate is a provision to,

> ...retrain teachers and other education personnel to become better qualified to
> teach in subject areas necessary to prepare students for the high technology era
> -- mathematics, science and computer technology.

In the teacher center model all participating groups, school districts, private sector businesses and industries, and post-secondary institutions, work collaboratively to provide staff development services to teachers. The NYSTEP Resource Agents have been oriented to use of teacher centers for conducting workshops and some agents conduct workshops through them now.

(3) The Staff/Curriculum Development Network (S/CDN) is operated cooperatively through NYSED and the state's forty-two intermediate educational agencies (Board of Cooperative Education Services). This network uses teachers as turnkey trainers for state syllabus awareness and dissemination activities. Most recently, the S/CDN has been effectively used by the NYSED Bureau of Science Education to provide extensive, statewide staff development activities associated with the State's new elementary science program evaluation. The S/CDN network has also been a most effective method for statewide teacher staff development for those NYSED Bureau of Science Education secondary school syllabi which have been recently developed, or revised and reissued.

The need to magnify the staff development activities performed by NYSTEP Resource Agents through additional staff development networks is apparent considering the magnitude of the effort; over 1,500 middle-level science teachers in grade 7 in New York State, teach science to 200,000 middle-level students (similar statistics for grades 8 and 9). The mechanisms which have been described will permit vigorous response to an anticipated strong interest in and demand for staff development in STS education, in the new middle-level science modules, and in the new middle-level science syllabus.

The NYSTEP staff also have major responsibility for seeing that private and public sector scientists are integrated into the local and State staff development activities conducted by NYSTEP Resource Agents. This is achieved by staff members serving liaison functions to identified representatives of research organizations such as the Atmospheric Sciences Research Center at SUNY-A, to professional organizations such as the National Association of Education/Industry cooperation and to educational representatives of the electric and gas utilities who help recruit scientists and engineers from that industry.

The development of a comprehensive middle-level science curriculum shall have national applications. The products of curriculum development and the dissemination model will be shared enthusiastically nationwide with other State Education Agencies, school science supervisors, and professional associations in order to encourage and promote widespread dissemination of products and processes, and to aid the efforts of all to restructure middle-level education.

TOXICOLOGY, AN STS APPROACH

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ABSTRACT

This research unit on toxicology is suitable for high school biology, chemistry, or environmental science classes. It could be utilized at the college level in an STS course. The unit was developed in a partnership program between Rohm and Haas and the Wissahickon School District during the summer of 1989.

INTRODUCTION

The following suggested activities were developed through Project L.A.B.S. during the summer of 1989 as a partnership program between Rohm and Haas and several school districts. This project was part of the chemical manufacturer's effort to promote science education in public schools. What evolved was a sourcebook for teachers with lesson plans and activites to help students in "Learning About Basic Science".

The toxicology section of the sourcebook included information contained in The Dose Makes the Poison; A Plain Language Guide to Toxicology, (Ottoboni 1984) and Understanding Chemical Exposure,Toxicology and Public Health Cornell computer program. (Appling and Fessenden 1987).

It is suggested that the information contained in these or other sources be made available to the student before attempting to do the suggested research. An attempt was made to tailor questions and topics to include a variety of subject areas as well as age levels. This approach should encourage correlation between the various disciplines.

We live in a relatively "hostile environment", and in a world where everyone wants guarantees. By studying issues involved in the area of toxicology it is hoped that students will explore the multi-faceted "risk-benefit" equation.

SUGGESTED RESEARCH

Select a chemical and describe its typical route of entry. What are the acute as well as chronic effects to humans? What are the most likely ways in which humans would be exposed to the chemical? Weigh the benefits of using the chemical against the risks of exposure.

Select one toxin and describe in detail its chemical properties. How do these properties affect its toxicity to living things?

In determining the LD50 (lethal dose) for a particular compound, it is known that a certain percentage of individuals tested will not survive a fraction of the LD50, while other individuals will survive much higher doses. In addition, some species have a higher tolerance for certain substances than others. Discuss the factors which affect individual suseptibility and why the LD50 is the benchmark used by the toxicologist.

Report on defense mechanisms our bodies have developed to survive chemical insults. How may bioaccumulation actually be beneficial to the body?

Chemicals may be mutagenic, carcinogenic, or teratogenic. Select one effect and discuss how these properties are investigated. Find as much information as possible on a chemical or several chemicals which have been shown to exhibit the effect in humans.

Make an inventory of substances in the home which contain toxic substances. Compare the risks and benefits of using each. Find out about the proper way to handle and dispose of these products.

Carbon 14 is used as a tracer in mechanistic toxicology. Report on how tracers are used in other areas; radiocarbon dating, in medicine, in industry, etc. Why is carbon 14 useful in these applications? What other isotopes are employed?

Select one of the environmental laws enacted by Congress. Give a brief description of what the law requires. How were "acceptable standards" developed and what are they? How effective has the law been in achieving its aim? Discuss the proponents' as well as opponents' views on the legislation.

Report on the problem of accidental poisoning in the home. Discuss proper storage, first aid, and find the number of the nearest poison control center. Based on the information below, how might accidental poisoning be reduced or eliminated? Construct a list of poisons and their antedotes.

According to statistics it is believed that one third of cancers are caused by lifestyle (exposure to tobacco, alcohol, etc.), and one third are linked to diet. This means that one third of all cancers are due to other factors. What are some other factors? What percentage of cancer in the U.S.A. are caused by exposure to industrial chemicals?

The Risk Benefit See Saw

Many miracle chemicals are like a double-edged sword. They offer benefits while at the same time posing risks. It is important to determine which compounds are most likely to cause problems to the general population, and to minimize human exposure. At the same time it is desirable to utilize compounds which can improve our standard of living. This is the task of the toxicologist; to assess the risk posed by exposure to chemicals, while at the same time evaluating potential benefits to society through its use. Examine the list below and see if you can find other dichotomies. How might risks be minimized, while benefits maximized?

1. In 1905 there were about 5,000 cases of typhoid in Philadelphia. The disease was spread by pathogens in drinking water. It was found that by chlorinating drinking water, pathogens were destroyed and typhoid was all but wiped out. In 1972 it was found that chlorine in water could combine with organic matter to form chloroform ($CHCl3$), a compound known to cause kidney tumors in rats, and liver tumors in mice.

2. Low colesterol diets have been found to increase the risk of colon cancer. High colesterol diets seem to be directly related to the incidence of cardiovascular disease.

3. Nitrites are used to cure meat and prevent the growth of botulism organisms but increase the risk of stomach cancer in humans.

4. Birth control pills prevent pregnancy but may produce chronic effects.

5. Estrogen compounds are useful in treating distressing symptoms in menopausal women, but at the same time increase the risk of uterine cancer. Estrogen has also been shown to protect against osteoporosis.

6. By making our homes more energy efficient, we have sealed them up and used insulation which may give off formaldehyde gas.

SPIN-OFFS, GOING BEYOND

Man-made or Natural; Is it Toxic?

Environmentalists frequently cite arguments against synthetic compounds; (1) they are man-made, (2) they are non-biodegradable, and (3) they have very complex structures. See NY Times Magazine, 9/25/77 article by Barry Commoner; prominent spokesman for the movement.

It may be argued that none of the points listed above pertain to the toxicity of chemicals. For example, (1) the fact that a compound is man-made has nothing to do with its toxicity. Many of the most toxic substances known to man occur naturally. Secondly, (2) biodegradablility has little to do with whether a compound is toxic. In fact, in the process of decay, biodegradable substances may be converted to compounds which are even more toxic than the parent molecule. In addition, toxic compounds may be rendered non-toxic through the metabolic process. Finally, the complexity of molecular structure has little to do with toxicity. Enzymes are produced by living things and are some of the most complex molecules in existance. On the other hand, there are many inorganic compounds which are highly toxic that have relatively simple structures (cyanide, arsenic, etc.).

SOCIAL STUDIES

Legislation and Enforcement

Select a law, piece of legislation in the process of being passed or other legal aspect of environmental law. How does the government enforce existing environmental legislation, and how are penalties assessed?
What role do private environmental and consumer groups play in the establishment of legislation? To what extent is labor involved in the safety of workers, etc.? How do corporations lobby through trade organizations? What is the role of the scientific community in determining toxicity, and making decisions regarding what substances are safe for use in the home, workplace, and industry?

Historical Perspective

The first monograph on occupational diseases was published in 1567, 26 years after the death of its author; Paracelsus, a Swiss Physician. In it acute and chronic toxicity were defined and the toxic effects of metals were described on the basis of their effects on miners and smelters. Chronic effects of mercury were described in detail. In addition, Paracelsus designed a chemotherapy for syphilis which utilized mercury.

"What is it that is not poison? All things are Poison and nothing is without poison. It is the dose only that makes a thing not a poison."

Bernardo Ramazzini, father of occupational medicine, was born in 1633 in Italy and lived to the age of 81. He devoted his life to improving the quality of life among the common man. He studied occupations by following his subjects into their workplaces; whether they be mines, cesspools, or workshops.

As early as 1775, Sir Percivall Pott detected a cause and effect relationship between soot and the occurrance of scrotal cancer in chimney sweeps. This is amazing in light of the fact that as recently as 40 years ago it was not generally accepted that certain chemicals could cause specific cancers.

Friedrich Woehler, a German chemist first synthesized an organic compound; oxalic acid. Until he did so it was believed that only living things could produce organic molecules. In the early nineteenth century it was widely held that the special properties of organic chemicals were due to an incomprehensible "Vital Force" (1823).

HEALTH: It's in the Food We Eat

There are over 2,000 chemicals approved by the Food and Drug Administration (FDA) for use in food. These include spices, flavors, colors, emulsifiers, preservatives, sweetners, dessicants, thickeners, and stabilizers. There are also substances which are approved which come in indirect contact such as machine oils and chemicals which leach out from packaging.

The Delancey Clause of the 1958 Food Additives Act ammended the act to require that any chemical used as a food additive must be considered carcinogenic if it produced cancer in any animal species at any level of exposure.

What power does the consumer have in determining what chemicals are used and what products are available?

Accidental Poisoning

The Los Angeles Medical Association's Poison Control Center has gathered statistics on the calls it has received in the past thirty years. On the basis of calls received certain trends are evident;

1. There are no deaths in children prior to crawling age, and most deaths occur to children less than five years old. The number of children poisoned peaks between two and three years of age, and declines after the age of three.

2. Most calls are received between 10 A.M. and noon, and again between 4 P.M. and 6 P.M. These are times when the youngsters are hungry, and when adults may be busy preparing meals.

3. The children that ingest toxins frequently do so more than once. Generally these are bright, active, mischievious youngsters.

Invividual Suseptibility

In 1937, a new wonder drug called Sulfanilamide was introduced for treating bacterial infections. The elixir contained; 10% sulfanilamide, 72% diethylene glycol, and 18% flavoring and coloring. Diethylene glycol was used as a "vehicle" because it readily dissolved sulfanilamide.

Within a very short time of its release, it was found that the elixir was responsible for hundreds of people becoming ill, as well as 76 deaths. For those who survived, some had taken as much as 10 oz. of the drug, while some of those who died had taken as little as 1 oz. of the drug.

What was responsible for the toxic response? Was it the sulfanilamide, the diethylene glycol, or was the elixir tainted with some impurity? Through animal studies, it was determined that the diethylene glycol was responsible for the deaths.

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CREATIVE ENVIRONMENTAL DRAMATIC OPPORTUNITY: An Interdisciplinary Approach to Combine Earth Science and Drama for 8th Grade

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Ideas for this eight week project arose from a desire on Don Miller's part to create an experience that would challenge students to research environmental issues, then perform a unique play. He approached Nadine Butcher with the concept, and she suggested the play be written by the students themselves after they had done the research. From this came our current effort.

The project was piloted during the 1988-89 school year in Nadine Butcher's challenge Earth Science class of 28 highly motivated students. During the 1989-90 year we worked with a mixed ability class on the project. Our schedules have allowed us the rare opportunity to team teach this unit, allowing us to stress the connections between the disciplines and help our students reach a higher level of understanding in both suject areas. We hope to leave them with an experience which impresses upon them how two very different subject areas can be productively related.

Our rationale for the project was first to teach kids about science and environmental issues in a creative and entertaining way. Secondly, we wanted them to learn playwriting skills that would enable them to write a well designed play. Finally, we wanted them to produce a unique play based on important scientific and environmental issues.

The CEDO project provides an excellent opportunity for students to refine their research and questioning skills. The process of taking a topic from research to play requires detailed analysis of the topic, and extensive synthesis of the material once the information has been found.

The project is introduced with two activities designed to enhance the students questioning and analysis skills: THE BABY KIDNAPPING SCENARIO has them imagine they are reporters uncovering information about a crime; and the ALLIGATOR RIVER STORY requires detailed analysis of written information and introduces them to plot analysis.

Following these initial activities, students are divided into groups of four and five to research their science topic. Within the groups, each student has a role and is expected to fulfill certain responsibilities. All are expected to use primary and secondary resources during their research, and to keep a record of their sources. Initially, students are allowed to research as they see fit. After a day or two (usually of frustration) we repeat the process of the Baby Kidnapping questioning activity with them, this time in the context of their topic. They are then instructed to create a series of questions to guide their research. After another day or two, groups are provided with content guide sheets that ensure they are thorough in their work and have considered the social implications of their topic. Students are expected to achieve a very high degree of understanding of their topic, and are then required to present their information to rest of the class. It has been teacher discretion whether or not the student groups are also required to create an outline and/or paper on their topic.

Once students have an excellent understanding of their topic and initial exposure to the work of fellow students, the DRAMA PHASE and story synthesis begins: each individual is directed to write a SIMPLE STORY based on their topic.

We introduce this assignment having students read Burning With a Blue Flame (Dee), a vignette about carbon monoxide poisoning. If students still have difficulty comprehending how they could possibly write a story about all of the information they have, we use the song Look Out Any Window by Bruce Hornsby and the Range, or act out an example ourselves, based on the life of a scientist. For each example we point out where the science comes through, how peoples' lives were used to tell the story, and the details necessary to convey the message.

Once the stories are written, students trade stories and analyze the characters and plot of each using the process introduced with the Alligator River Story. Following analysis and feedback to the authors, each student group agrees on the story BEST representing their topic. From this story, each group writes a vignette. (In some cases the groups have been capable of collaborating to write a vignette; in others, each individual wrote her/his own version of the story, and the group united to create one final version.)

Vignettes, once written, are submitted with a detailed analysis of the characters, based on a CHARACTER EVALUATION SHEET we provide, and of the plot, using the PASTO Technique (Trank)-----analysis tools that further refine analysis skills used in the Alligator River Story. Students must be able to articulate a very specific main message, and describe the setting(s) for their play.

Vignettes are shared with the Freeing the Natural Voice activity (Linklater), which also ensures students thoroughly understand their final version of the vignette. Each group creates a 'story telling' experience for the class as one member of the group takes the scarf and begins: "I was there...". In the first person, the student recounts part of the vignette. At some point in the story (can be prearranged) another member takes the scarf saying "I was there also......" . Group members trade off until the story has been recounted in its entirety. Properly introduced, this can be a very special time for the class as they share the work they have done.

Finally, to ensure a high level of student assimilation of each story, the teacher leads the students through a visualization process called Dropping In (Coleman). This activity must be introduced carefully as students can get silly if the purpose is not well explained; it will go more smoothly if the process of questioning and group response are explained in advance. The teacher carefully orchestrates questioning and answering to get students in touch with the feelings and broader meaning behind the key words from each vignette.

Now students are ready to stage their plays: the work has just begun!. Students from the first year of this project gave outstanding performances on April 5, 1990 at Missouri Botanical Garden in St. Louis, Missouri. This years' students entered their vignettes in the National History Day contest, the theme of which was Science and Technology in History. Two groups took first and second place in our district, and went on to give excellent performances for the Missouri State competition.

In both cases this project has created a sense of purpose and comraderie in the classes that participated. By the time the plays were ready for production, both classes had evolved into a cooperative group---each student pulling for the other. Their research skills, and their ability to handle frustration also have been enhanced. Finally, the combination of disciplines reaches a wider range of the students in the class: those not usually interested in traditional science academics are intrigued by the drama, and those who favor academics reach beyond themselves and learn even more.

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TWO LESSONS TO TEACH ABOUT THE GREENHOUSE EFFECT

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The following two lesson plans were submitted as part of a session in which a larger number of lesson plans on the same subject was presented.

LESSON PLAN: How carbon dioxide produces a greenhouse effect (high school physical science)

Objective

[] Students will demonstrate how carbon dioxide in the air acts to increase the temperature of water below it.

Background

[] The earth's climates are determined by the energy the earth receives from the sun. When this energy is absorbed by the earth, its temperature increases. Since the average temperature of the earth stays pretty much the same, though, the earth gives off to outer space as much energy as it gains from the sun. It does this by radiating electromagnetic waves.

All objects radiate electromagnetic waves according to their temperature: the higher the temperature, the higher the frequency. With the high temperatures at the surface of the sun, the electromagnetic radiation is mostly visible light. With lower temperatures, objects on earth radiate electromagnetic waves with slightly lower frequency -- in the infrared region.

If one calculates the earth's temperature by balancing the incoming energy from the sun with the infrared radiation given off by the earth, the result is about 45^{o}C colder than earth's average temperature of 17^{o}C. This 45^{o}C difference, which was very crucial to the development and continued existence of life on earth, is due to carbon dioxide in earth's atmosphere. This carbon dioxide absorbs the infrared radiation emitted by earth and reradiates some of it back to earth. By limiting the escape of infrared radiation given off by the earth, the carbon dioxide acts like a greenhouse. Carbon dioxide is thus called a *greenhouse gas* and is said to produce a *greenhouse effect*.

The temperature of the earth is the consequence of *radiative equilibrium* between sun and earth. Radiative equilibrium between sun and earth and its dependence on carbon dioxide is seen in the suggested activity below.

Strategy

[] After presenting the above background material, have students investigate the effect of carbon dioxide on the temperature of water below it, following the procedure below, and answer the subsequent questions.

Materials

[] 150 - 250 watt lamps

[] 2 1000 mL beakers

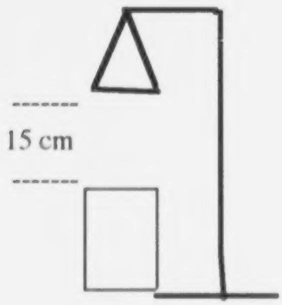
[] thermometers

[] water, seltzer water

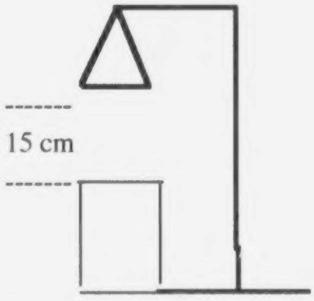
Procedure

[] Pour 100 mL tap water into one 1000 mL beaker. Pour 100 mL seltzer water into a second 1000 mL beaker.

[] Place each beaker about 15 cm under a 150 - 250 watt light bulb (the same type light bulb for each beaker).



water



seltzer

[] Place a thermometer in each beaker and measure the temperature of each liquid.

[] Turn on the lights. Measure and record the temperature of each liquid every five minutes for thirty minutes in a data table.

Questions

1. In which liquid is the temperature increasing more rapidly?

2. How does the temperature increase in the first five minutes compare with the temperature increase in the last five minutes?

3. Do you feel that there is a limit to how high the temperature can go in either liquid? Why or why not?

4. If the temperature reaches a limit, what is the relationship between the heat gained from the lamp and the heat radiated by the liquid? This relationship is the condition for radiative equilibrium. How does this apply to the earth and sun?

5. The gas given off by seltzer water is carbon dioxide. What effect does the carbon dioxide have on the temperature of the liquid beneath it? How does this apply to the earth and sun?

Author's Note: This lesson is based on material developed with other teacher writers for NSTA's Project for an Energy Enriched Curriculum at the University of Maryland during the summer of 1979. It has been used since then in the ninth grade physical science course at The Calhoun School.

LESSON PLAN: Investigating consequences of the greenhouse effect (high school physical science)

Objective

[] Students will be able to describe secondary and tertiary as well as primary consequences of an increase in the average temperature of the world.

Background

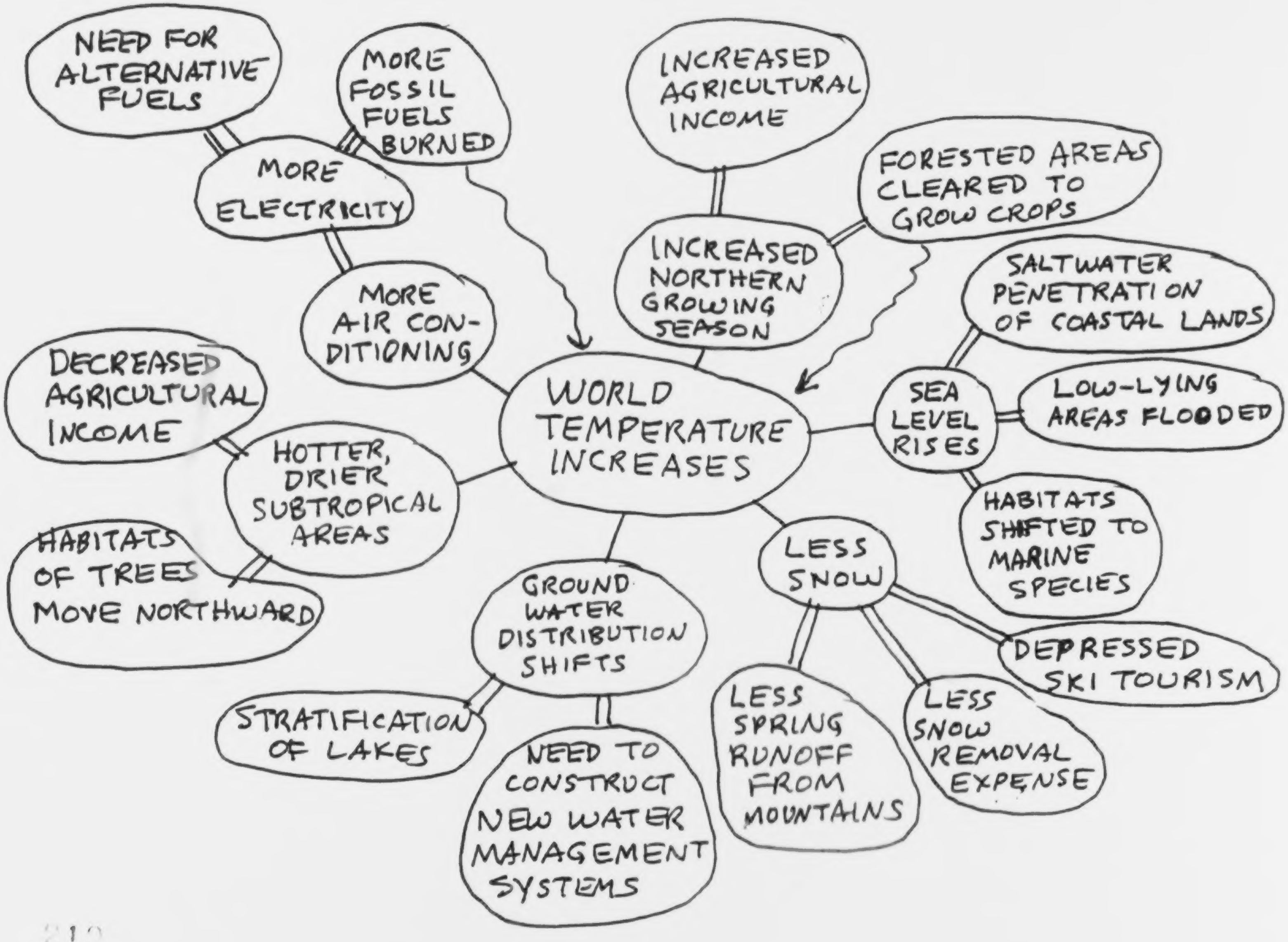
[] The Futures Wheel, originated by the Acid Rain Foundation, is a useful technique to investigate the secondary and tertiary as well as primary consequences of a given change. It involves starting with a "what if . . . ?" and responding with as many consequences as possible. These are arranged around the original "what if" and connected to it like spokes of a wheel. These primary consequences themselves have secondary consequences, which are then linked to the primary consequences by a double spoke, *etc*.

Suppose you take for your "what if" the following: What if the earth's temperature increased the 3^{o}C predicted by doubling the atmosphere's carbon dioxide? The wealth of possibilities is suggested by the Executive Summary of the Environmental Protection Agency's Draft Report to Congress, "THE POTENTIAL EFFECTS OF GLOBAL CLIMATE CHANGE ON THE UNITED STATES" (October 1988). A sample Future Wheel based on this document is provided.

Activity

[] Have students, either singly or in groups, develop their own Future Wheel to show the consequences, primary, secondary, and tertiary, that could develop from an increase of the world's average temperature.

Author's Note: The preceding activity was originally developed for the Climate Protection Institute's *Greenhouse Gas-ette*.


NEED FOR ALTERNATIVE FUELS
MORE FOSSIL FUELS BURNED
MORE ELECTRICITY
MORE AIR CONDITIONING
INCREASED AGRICULTURAL INCOME
FORESTED AREAS CLEARED TO GROW CROPS
INCREASED NORTHERN GROWING SEASON
SALTWATER PENETRATION OF COASTAL LANDS
DECREASED AGRICULTURAL INCOME
WORLD TEMPERATURE INCREASES
SEA LEVEL RISES
LOW-LYING AREAS FLOODED
HOTTER, DRIER SUBTROPICAL AREAS
HABITATS SHIFTED TO MARINE SPECIES
HABITATS OF TREES MOVE NORTHWARD
LESS SNOW
GROUND WATER DISTRIBUTION SHIFTS
DEPRESSED SKI TOURISM
STRATIFICATION OF LAKES
LESS SPRING RUNOFF FROM MOUNTAINS
LESS SNOW REMOVAL EXPENSE
NEED TO CONSTRUCT NEW WATER MANAGEMENT SYSTEMS

DEVELOPING STS CLASSROOM ACTIVITIES

by

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This is a technological society and teachers readily recognize the need to develop their students' understandings of the interactions of science and technology with society. However teachers usually have expertise in only one of the three areas of science, technology or social studies. They can easily develop excellent instructional activities in their own specialty, but welcome assistance in including the other two areas to reveal the mutual interactions of those subjects.

This session was designed to provide the participants with STS classroom activities as well as new sources of activities and demonstrations that would include learning or using knowledge in all three areas of science, technology and society.

Dr. Galey emphasized the publications of the National Association of STS. Both the STS Reporter and the Bulletin of Science, Technology and Society regularly publish reviews of print and media materials about STS. For the reviews of media materials, a graphic device is used to identify, at a glance, the primary and secondary STS connections included in each item.

She then described briefly an instructional television series, titled You, Me and Technology. It is based on a curriculum of STS, using the 12 major topics of STS. Those topics include: consumerism, information processing, energy resources, four technological revolutions, communications, transportation, and risk and safety. The Teachers' Guide is available at modest cost from the Agency for Instructional Technology; Box A; Bloomington, IN 47402-0102. The activities were all written and tested in the classrooms by teachers from across the nation.

Recognizing that every teacher does not have access to the itv series, the presenter made the point that the activities in the Teacher's Guide could be used without having the programs. The example given was The Technology Spiral, the program describing lives of human beings in relation to the four technological revolutions.

After the students have studied those four periods, with or without the video program, the newspaper activity is lively and effective. The students are divided into four groups and each is assigned one of the technological periods. Given two clean sheets from a large easel pad and 2-3 markers of different colors, each group writes a newspaper with three headlines, three want ads for jobs and three ads for products and a topic for an editorial.

For the early tool-making period, the group produced "The Clay Tablet" with headlines of "Fire Discovered by Cave XII", "New Sources of Flint Located", and "Migration of the Clan Begins Soon". The jobs were, "Wanted, man to produce ten spearheads a week. Pay one hide per week and all he can eat", "Class on making fire with flint in Cave III. Bring your own flint pieces", "Mighty hunter wants wife with strong teeth to cure hides". The products were "Fine Arrow in Cave VII", "Magi Herbs to Cure Swollen Joints. See witch doctor", and "Strong bone needles for sale in Cave VI". The topic chosen for the editorial was "Is Cooked Meat Safe to Eat?". Humor and creativity make this assignment a pleasure while providing insight into the impacts of: science (geology to find flint); the technologies of making arrowheads and fire; and the effects on the lives of the people in their jobs and in what they can produce.

Another book of STS instructional activities in You, Me and Technology Video Series Activities. Again this book is written to correlate with the itv series, but can be purchased separately. This student workbook leads the students through exciting decision-making based on hands-on activities ad data collection. These activities require more time (two or more class periods) to conduct than those in the YMT Teachers' Guide. These books can be purchased for about $10 from: Delmar Publishers Inc.; Two Computer Drive, Box 15-015; Albany, NY 12212.

Dr. Piel continued by describing his use of tv as a source of STS activities. He keeps a videocassette in his vcr at all times to be ready to record news clips or whole programs on STS issues. For example, there was a tv special "50 Ways to Save the Environment". The program showed a number of environmental problems and potential solutions which citizens can employ to alleviate those problems. A science teacher could use this program by showing only the problems in the first part and then challenging the students to devise hands-on experiments to use science to help understand the causes of the problem and to propose scientific solutions. Discussion of the social impact and social limitations on the scientific solutions proposed is very important.

Social studies students could identify the social causes and/or effects of the problem. They might conduct surveys in the school or community to determine the acceptability and feasibility of solutions they have developed. The science and technology factors should be identified to affect the students' final decisions.

Please Note: There are legal limitations on how long off-air videocassette can be used. Be sure you follow the copyright protection procedures required by your school.

Many schools have portable tv equipment and 35mm cameras which can be used to record STS problems for classroom use in recommending solutions. Dr. Piel gave the example of recording hazardous road conditions in the city or on the highway to determine the science in the causes and possible solution to reduce or to eliminate the hazard.

For their English or social studies class, the same students might use the tv or film record to show their fellow students, the school administration, and even the town council, the nature of the hazard and their proposed solutions. This kind of activity has been accomplished to improve the school environment, bicycle safety, and water conservation in various communities. These hands-on activities and their accomplishments integrates the students' learning of science, technology and society to make the school part of the real world.

In concluding this section, Dr. Piel pointed out that the daily newspaper, like the tv news, is an excellent source of STS problems to be addressed in the classroom.

Dr. Paul Bell and Dr. Randall Weisenmeyer of Pennsylvania State University shared a different approach to developing STS classroom activities. For at least four years, they have obtained funding to teach summer STS Workshops for teachers in western Pennsylvania. The objectives for those workshops included: (1) Teachers will experience science in the context of social responsibility rather than a separate and neutral activity, and (2) teachers will be empowered to feel that they can teach STS.

The teachers identified and classified STS issues with particular attention to prioritizing values. Then each team of four teachers began developing STS activities requiring their students to use primary and secondary sources; do hands-on experiments to collect data; and then propose actions appropriate for STS decisions. At the opening of their respective schools, the teachers would first initiate these activities in their own classes and later develop cooperations with teachers of subjects other than science. Samples of the activities developed by these teachers were distributed to those attending the session. They hope to publish these activities.

In summary, new sources of STS teaching materials were described in both print and media formats to encourage the introduction and use of STS concepts and topics by teachers in their classrooms.

FUEL CONSUMPTION: A BURNING ENVIRONMENTAL QUESTION
Research into students conceptions

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1. Introduction

May 2th 1989 was a historic day in the Netherlands. For the first time in history a Dutch government fell over an environmental issue: a conflict concerning the lapse of tax reduction for traveling expenses of commuter traffic. The background of the proposed measure was the belief that it would bring people to live nearer to their work. In that way it might lead to a reduction of motor traffic. The incident illustrates the prominent position of the environment nowadays on the political agenda.

Although the environment has never been away from the scene since the seventies, the last four years it is without doubt political priority number one for the great majority of the Dutch people. As a consequence every political party from the right to the left calls itself green. The most popular colour of our days. In the slipstream of these developments environmental education is getting more and more attention from the government.

A major step in the implementation of environmental education in formal (secondary) education was set by the *Project on Environmental Education in Secondary Education* (Dutch acronym NME-VO), which ran from 1986 until 1989.The NME-VO project had the task to develop teaching materials and a curriculum on environmental education which were suited to the existing syllabi of the subjects biology,chemistry, geography and physics. Teaching units have been developed on *Wetlands, Meat, Fuel, Noise, Pesticides* and *Waste.*

In the course of the project decision making became more and more a main point. In this paper we discuss the contents and structure of the teaching unit Fuel in more detail and some research results on aspects of decision making.

2. The Dutch project of environmental education (NME-VO)

A detailed description of ideas and results of the NME-VO project as a whole is presented by Van der Loo (1990). For our purpose here a short summary of the principal characteristics will suffice.

The main strategic goal of the NME-VO project is formulated as:

Students are enabled to take a sustainable development of the relation between man and environment into consideration in their opinions and behaviour.

This formulation implies two important subgoals. Firstly, students have to get knowledge of the relationship between man and the environment. Secondly, this knowledge has little meaning in itself but should be made productive in making decisions on environmental issues. Figure 1 shows a model of the relation man - environment that has proven to be very useful in the development of a curriculum and teaching materials for environmental education (Pieters, 1988).

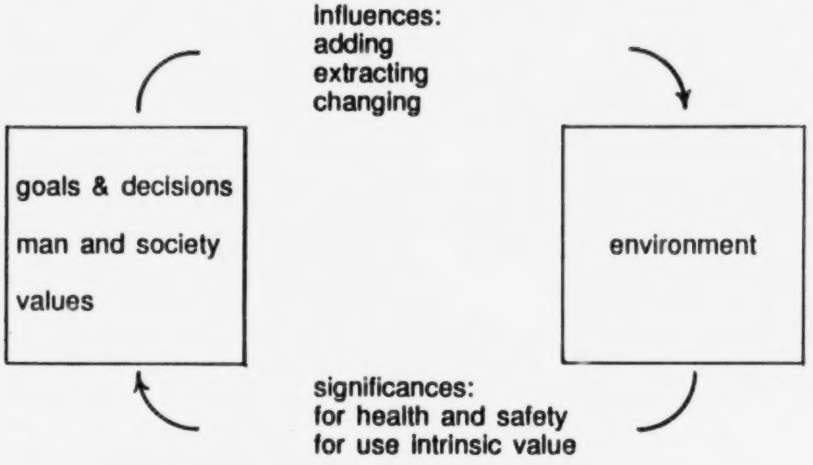

Figure 1:The relation between man and the environment.

The model relates the following concepts:

- The environment has several significances for man. It has significance for his health and safety, it can be used for economic purposes and man can attach an intrinsic value to it, apart from any use.
- Environmental significances are exploited by human interventions: extractions (matter and energy), additions (e.g. waste) and changes (e.g. buildings).
- Interventions can affect the significances of the environment in a negative way. In that case we speak of depletion, pollution and deterioration.
- Affected significances are in fact environmental problems. Environmental problems ask for solutions. In most cases more than one solution is possible and should be considered. And with that we have come to decision making

3. Decision- making in environmental education

Decision making is an important theme in discussions about the contents of STS-educational courses. (Watson, 1980, Zoller 1982, Aikenhead 1983, Kortland and Van der Loo 1986). The most frequently heard motive is the idea that science education has to contribute to the social preparedness of students. Education has to prepare students on their (future) roles as consumers and as responsible citizens (Eijkelhof and Kortland, 1987). In those roles they will have to make numerous decisions with environmental implications. It is therefore not surprising that the Brundtland-report mentions 'making informed choices' as a crucial element in dealing with environmental issues. The report also emphasizes 'the right of individuals to participate successfully in decision-making on activities likely to have a significant effect on the environment' (World Commission, 1987). Viewed in that light decision making skills are an essential part of environmental education.

Up to now there are several descriptions of educational courses practicing decision making skills. However, research into the outcomes of such courses is scarce.

Part of an explanation for this lack is the big gap between the theory and practice of decision making. Especially in the economic sciences a lot of research has been done on how human decisions are being made in reality. Starting from a normative phase model of decision making (Brim, 1962; see figure 2) the conclusion was once and again that in reality the human decision process is not a reflection of this systematic phase model. On the contrary human decision makers behave chaotically, switching from one phase in the decision making process to another, apparently without any clear plan in mind (see e.g. Witte, 1972).

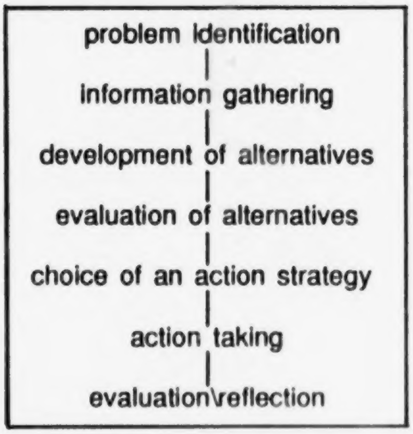
problem identification
information gathering
development of alternatives
evaluation of alternatives
choice of an action strategy
action taking
evaluation\reflection

Figure 2: Phase model of decision making (Brim, 1962)

So, can decision making be taught at all? And how relevant is the systematic phase model for education? Does the structuring of decision making helps students to increase their decision making abilities? However, teaching decision making, on more or less unknown topics and introducing new arguments as in environmental education will often be the case, and not giving a clear structure will certainly confuse students and will not work at all.
The phase model offers important advantages:

- a monitor function in the decision making process
- a possible structure for teaching units
- leads for evaluation (Woodley and Driscoll, 1977)

Accordingly, most educational courses are more or less structured by the phase model.
Also in the NME-VO teaching materials the decision making procedure is structured following the scheme represented in figure 3. This scheme reflects the stages of the phase model. The scheme points out that knowledge of the man-environment relation and values determine the perception of (environmental) problems and possible solutions. But at the same time the scheme expresses that the ultimate choice is also determined by other, non-environmental considerations.

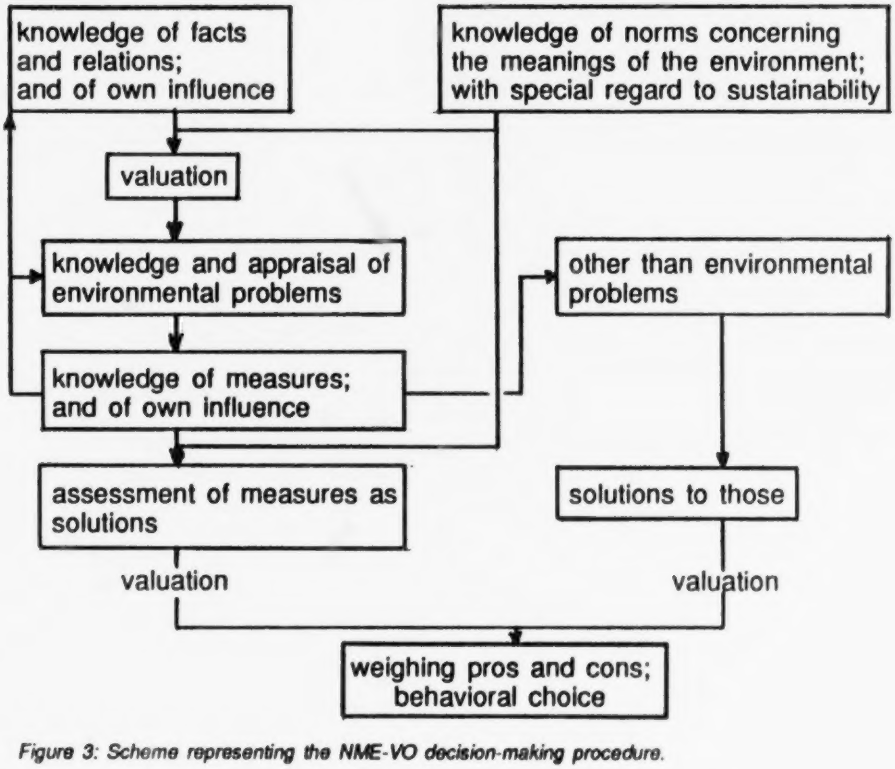
knowledge of facts and relations; and of own influence
knowledge of norms concerning the meanings of the environment; with special regard to sustainability
valuation
knowledge and appraisal of environmental problems
other than environmental problems
knowledge of measures; and of own influence
assessment of measures as solutions
solutions to those
valuation
valuation
weighing pros and cons; behavioral choice

Figure 3: Scheme representing the NME-VO decision-making procedure.

The discrepancy between everyday life and the educational model of decision making indicates that there is an obvious need for research into the outcomes of educational courses practicing decision making skills, be it based on the phase model or not.
In this paper we go into three aspects of decision making in environmental education based on our experiences with the teaching unit *Fuel*:

- What do we intend by focussing attention on decision making?
- Which issues are suitable for decision making?
- How could decision making be structured in teaching units?

These aspects subsequently relate to the *goal*, the *contents* and the *structure* of decision making in teaching units.

4. The teaching unit Fuel: contents and structure

Fuel is designed for 14-15 year old students at the high ability level and for the subjects chemistry, physics and geography. The school subject structure in the first version of the teaching unit is shown in figure 4.

In the teaching unit *Fuel* the environmental effects of our energy use are discussed, ending in the planning of an urban area. The leading thread through the teaching unit is the key question: 'How would you design an attractive urban area, considering the effects of domestic energy use on the environment.'
In the orientation part the issue of the consumption of fuels and the key question are briefly introduced.
In the subject parts students are informed about the applications of fossil fuels, about the environmental problems and about measures which can be taken.
The chemistry part deals with air pollution caused by the burning of fossil fuels, products of combustion, and technological measures against pollution. The physics part starts with the depletion of fossil fuels and discusses various methods to save energy and also their efficiency. The geography part goes into the deterioration of the landscape and gives information about spatial planning procedures.

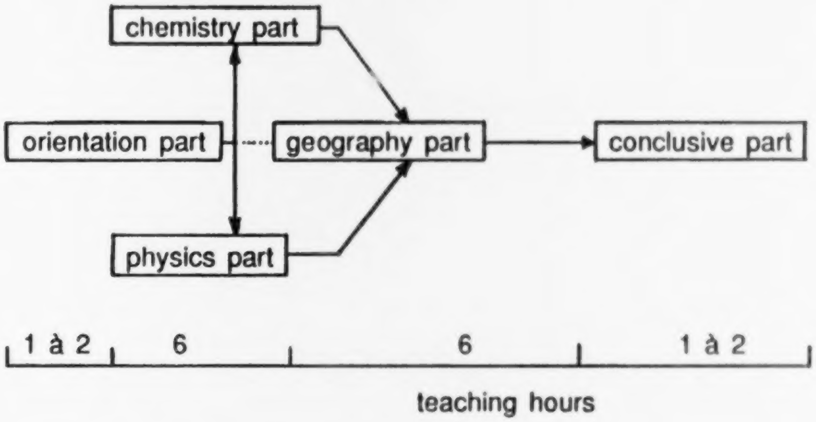

Figure 4: school subject structure of fuel

In the conclusive part students make a design of an urban area, taking the environmental aspects of the energy supply into consideration. Integration of the information from the subject parts and valuation of the facts is necessary to complete this activity. Finally the students evaluate each other's designs. They balance the environmental effects of the chosen energy supply against comfort of living.

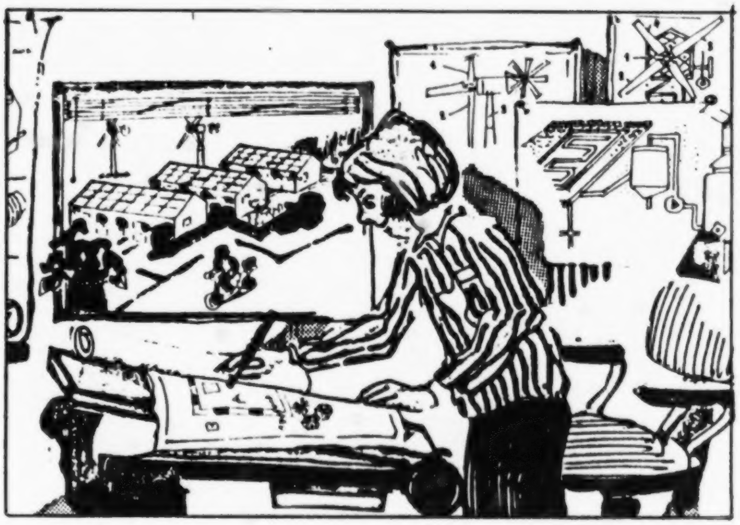

Figure 5: Designing an urban area

5. Research program and methods

Research has been done on the students' understanding of the environmental issues dealt with in the teaching unit Fuel, and on the outcomes of the learning process. Figure 6 shows the relation between research and development of this unit.

The research was in the first place meant to support the development of the teaching unit, and was therefore restricted in time and depth.
Decision making became an important topic only during the course of the project and consequently of the research. One should also bear in mind that the research was carried out on a first version of the teaching unit. First versions always suffer growing pains. Research carried out on first versions of teaching units therefore can't deliver definite conclusions about the ultimate success of the teaching materials (Eijkelhof and Lijnse, 1988). More in depth research is necessary and in preparation now to elucidate in more detail the conditions that are prerequisite for the training of decision making skills.

Fuel has been tried out in six schools. One hundred and fifty students of age 14-15 answered a questionnaire, before and after the teaching unit was dealt with in the lessons. This questionnaire was designed on the basis of a number of structured interviews with individual students about their views on the energy problem. The purpose of the interviews was to discover what knowledge and opinions students already possess with regard to the subjects dealt with in the teaching unit. In this way we got a first survey of the problem perceptions of students and the measures they had in mind to solve these problems.
In two classes the teaching of the unit was observed from beginning to end. Eight students from these classes were interviewed, before and after the teaching of the unit. Discussions between students on possible measures to solve environmental problems were taped in each class. The students wrote down their opinion and underlying argumentation beforehand on so called discussion sheets.
The advantages of this double registration are twofold. Firstly, this gives students time to think about the various alternatives and their own preferences. Secondly, opinions and arguments of students who don't have such well-oiled tongues are recorded.

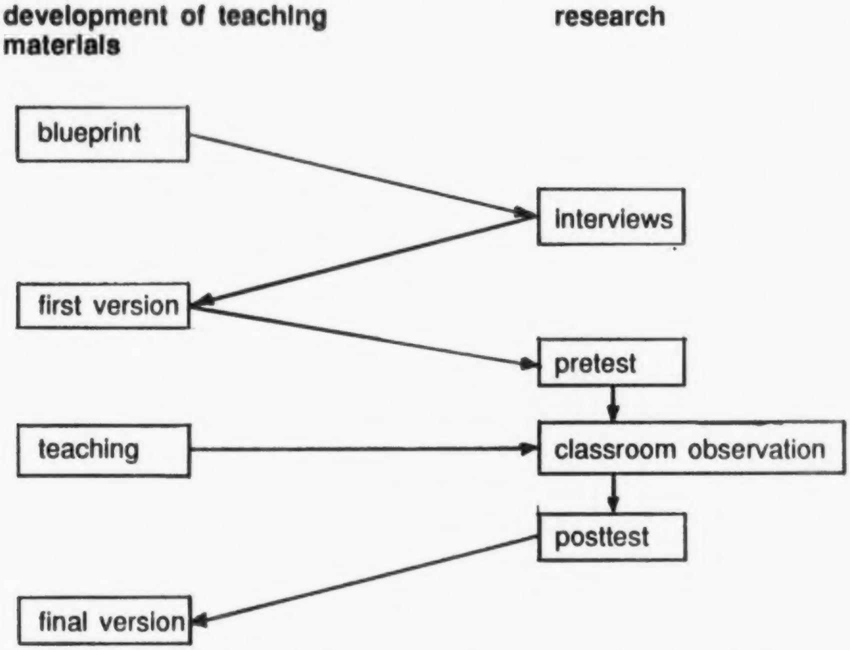

Figure 6: The relation between the development of the teaching units and development.

6. Students' perceptions

Broadly speaking a well-considered decision consists of three elements:
- a correct problem analysis;
- an inventory and evaluation of possible alternatives with all their pros and cons;
- choice of the most appropriate alternative.

It goes without saying that an incorrect problem analysis and/or a poor inventory and evaluation of alternatives are not the best basis for a thought choice. What goes for decisions in general holds also, of course, for decisions on environmental issues. For a deliberate decision it is necessary to have a good understanding of the environmental problem and of the possible solutions, and to be able to weigh the alternatives in a 'fair' way. Via interviews, questionnaires and discussion sheets we tried to discover students' perceptions of the environmental problems connected with fuel consumption, of possible solutions for these problems and their line of reasoning in making a choice.

Problem analysis
Getting insight in the environmental effects of fuel consumption is not that easy. First of all two main consequences of our fuel consumption have to be distinguished: depletion of fossil fuels and air pollution. Secondly, combustion of fossil fuels causes several environmental effects in the atmosphere: acid rain, smog, the greenhouse effect. Thirdly, there are more environmental problems in the atmosphere, hardly caused by fuel combustion, like the depletion of the ozone layer.
As could be expected many students don't see the wood for the trees. Their perceptions are often incomplete or incorrect and they tend to mix up different problems.

The views are often incomplete. For instance, students associate the notion 'environmental problem' mainly with pollution, whereas the notion 'energy problem' is associated primarily with the depletion of fuel. Depletion of fuel is thus not considered as an environmental problem. 'Energy problem' and 'environmental problem' are two separate concepts for the students. This stands in the way of an overall view on the problems accompanying the consumption of energy. The association of air pollution with, above all, acid rain, and thereby discarding smog and the carbondioxide (greenhouse) effect is another example of one-sided views. These views are influenced by the topics of the day. In the research period acid rain was an important item on TV and in the newspapers, whereas smog and the greenhouse effect were not.

Students often mix up different environmental problems. Figure 7 gives some illustrations of students' statements.

> "Acid rain? Yes, I have heard of that. In that place called Tsjernobyl something has exploded, that is called radioactive or something like that. And that is rather dangerous and it destroys all kinds of fruit in warm countries."
>
> "When burning fuel so much heat is released into the atmosphere that it has an influence on the climate."
>
> "Burning fuel damages the ozone layer. As a consequence the sun shines through easier and so the ice caps are melting."

Figure 7: Some examples of students' statements concerning environmental problems.

Inventory of alternatives

When asked for measures to save fuel students in the first place mention the substitution of fuel by other energy sources like sun, wind, water and nuclear energy. A second (smaller) group relates to saving measures on consumers' side as insulation of houses and a higher efficiency of apparatus. Students mentioned rather few measures that have consequences for their own behaviour. Differences between pre- and posttest were small.

Pros and cons of alternative energy sources were rather well known to students. However, there was a lack of knowledge with regard to the efficiency of saving measures on consumers' side, partly caused by an inadequate assessment of the energy use at home for different purposes as heating, electric apparatus, and so on.

The same picture appeared from a similar question on measures against air pollution. Students mainly mentioned technological measures as filters and car-catalysts (see figure 8). However, here we found a remarkable difference between pre- and posttest in the category 'fuel consumption'. In the posttest many more students mentioned measures which aim to reduce fuel consumption. Apparently these students' problem analysis became more complete after the unit was taught, including the relation between air pollution and fuel consumption. As a result their inventory of possible alternatives was more comprehensive.

	pretest	posttest
• air-/smoke-filters	58%	58%
• car-catalysts	54%	54%
• measures to reduce fuel consumption	31%	76%

Figure 8: Measures against air pollution

Making a choice

Does knowledge about the alternatives and their (environmental) pros and cons mean that students make the 'right' choice. In other words does environmental education bring students to better, ecologically sound decisions? We presented some choices to students in order to trace their line of reasoning. When students are asked for their preferences in items in which environmental aspects can't be overlooked, they take these into account. For instance, when facing the choice of how to generate electricity, the majority of the students choose for sun and wind energy. Coal and oil are turned down on the basis of environmental arguments. Generally speaking the argumentation of the students is more specific and more differentiated after the theme has been taught. Apparently they realize more than before that every choice has its advantages and its disadvantages. But environmental arguments hardly play a decisive part in choices. Confronted with possible measures to reduce air pollution by motor traffic, students reject measures that push back the use of cars. Instead they prefer technological solutions like car-catalysts. Environmental arguments lose to comfort and privacy. The same goes for the choice between different house types. Students were even indignant when asked why they didn't incorporate environmental considerations in their choice: *'when you are choosing a*

house, you don't look at the environment.'
These observations are in line with the willingness of students to contribute to energy saving. They support measures that yield money and do not affect comfort, like turning out the light on leaving home. Measures that affect comfort, like turning down the heating and putting on an extra sweater, are much less popular. Teaching of the unit doesn't change this attitude. On the other hand there is a change in students' motives to save energy, compared with the situation before the theme was taught (see figure 9). This change could be related to the more complete perception of the energy problem.

	pretest	posttest
• reducing pollution	22%	35%
• reducing depletion	59%	60%
• financial profits	71%	47%

Figure 9: Students' motives for energy saving

7. Discussion

In this paper we described some results of our research on students' perceptions with regard to the issue of fuel consumption.
Although the results lead to some conclusions on the construction of the specific unit *Fuel*, generalized conclusions on decision making in science education cannot be made from this research (see the remarks made in section 5). Yet, the results give rise to some comments on the implementation of decision making in teaching units on environmental education. Three aspects are relevant:

* What do we intend in focusing attention on decision making in environmental education?
* Which issue are suitable for decision making in environmental education?
* How could decision making be structured in teaching units?

These aspects subsequently relate to the *goal*, the *contents* and the *structure* of decision making in teaching units.

The goal of decision making in environmental education
Probably this is the most important question. What is it exactly we want to achieve by practicing decision making skills in environmental education?
We distinguish three possible goals of decision making in environmental education:

1. Students notice relevant environmental aspects of a decision;
2. Students use environmental arguments in a scientific correct way
3. Students take environmentally sound decisions, i.e. supporting a sustainable development.

Goal 1 is noncommittal, as goal 3 is the most far reaching.
From an exclusively environmental point of view one can argue that the ultimate goal of environmental education is the promotion of environmentally responsible behaviour. So, should this be our goal? There are three arguments why this should not be our choice. Firstly, our educational system offers little possibility for the promotion of such specific behaviour. We can't force students to come to school by bike instead of coming by moped. Secondly, and in our view a more important argument, forcing students to a certain behaviour conflicts with our goal to help students in becoming responsible citizens. Responsible citizens are capable of making their own decisions. The third argument is confirmed by our research results. Students are not tabulae rasae, they have their own beliefs, values and priorities. They resist decisions which conflict with these beliefs, values and priorities. For these reasons the NME-VO project formulated the main strategic goal of environmental education more modestly (see section 2).

The issue
It is a well-established adage in education to start from real life situations familiar to students. Fuel consumption is such an issue. This does not mean that students have a clear view of the problems connected with the issue. In the case of *Fuel* students didn't relate energy consumption and air pollution. Quite a number of students (approx. 25%, before the teaching) are not aware of the fact that electricity is generated by combustion of fossil fuels. These findings underline the importance of paying sufficient attention to a proper problem analysis. Sometimes the presented information induces students to unexpected conclusions. From the

information on the available methods to save energy, part of the students draw the conclusion that depletion of fossil fuels is not an urgent problem. It strengthens their belief that technological measures can solve the energy problem. It is important to evaluate alternatives on the basis of explicit criteria. Criteria which can be derived from the concept of 'sustainable development'. In that context the problem (that is the actual, undesired situation) can be discussed as the zero alternative.

There are also students who are skeptical about the effects of personal contributions to the solution of the energy problem. It is important to make clear in what way and to which degree alternatives contribute to the solution of environmental problems.

The structure

The teaching unit Fue ends with the design of an urban area. Students should take environmental aspects into account in their proposal for an energy system. It appeared that most students used the scientific information previously taught in only a superficial way. They gave more attention to the attractiveness of their design in terms of public gardens, planning of schools, shopping centre, traffic regulation, and so on. Part of an explanation for this is the separate teaching of the unit in different school subjects. Students (and teachers) had difficulties in relating knowledge obtained in chemistry and physics lessons to a geographical context. Therefore in the second version of the unit the design task is split up in two parts. In the first part students calculate fuel consumption and pollution for a number of given energy plans. In the second part they design urban areas on the basis of these energy plans.

The foregoing underlines that decision making activities in teaching materials need an explicit structure which enables students to integrate their activities. Teaching materials should be structured on the basis of the phases in the decision making model (see figures 2 & 3). An important question in this context is: what difference does it make for the teaching and learning of decision making, when students are asked to act according to their decision? Several authors (e.g. Zoller, 1987) emphasize the importance of incorporating this step in the decision making process. In the NME-VO project this stage is left out from the teaching materials. It is left up to the teachers to extend the decision making with action taking, rather than structuring this in the teaching units. Further research is needed to elucidate the educational advantages and disadvantages on this point.

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SO YOU WANT A COURSE TO INCREASE ATTENDANCE

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A few weeks ago, I was reading an article describing the product of the educational system. Let me paraphrase some of its conclusions.

The student of today has no taste for any sort of learning or inquiry, or any thought and inquiry. He grows feeble, dull and blind. His mind never wakes up or receives any nourishment. His senses are never purged of their deep fog. He ends up becoming a hater of learning, uncivilized. He is like a wild beast - all violence and fierceness. He lives in ignorance and evil conditions. He has no sense of propriety and grace.

By now, you might suspect that this article was not too contemporary. In fact, it was written about 2400 years ago by Plato in The Republic (Book III). So it appears that we didn't start this educational fire. It was always burning since the world's been turning. But even though we didn't light it, we should be trying to fight it. Basically it's our job to make sure it doesn't go on and on and on.

Today, I hope to show you one program that seems to be throwing some dry ice on the flames. But remember, when you attempt this program, watch out for the smoke from the melting ice. It can suffocate you. In other words, this program works for my school. Whether it is a panacea for others, I do not presume to know. My advice is, try it. You may like it. If it doesn't work, please don't call. Send me a letter with your complaints. Send it third class postage.

What kind of school is Alfred E. Smith High School? It is a vocational-tech school with three trades, Automotive, Building and Engineering. It has 1500 students, 95% male, 60% Hispanic and 40% Afro-American. Almost all of the students are from the Bronx, most from the South Bronx. The entering class is about 400 Ninth graders and 200 Tenth graders. The entering class profile is 7.2 Reading and 7.4 Math. This means that the average student is two years behind in Reading and Mathematics. If you remove the Engineering students who are on or above grade in both subjects, the students' profile is much lower.

In New York State, all students must pass a minimum of two years of High School Math. One of these can be in Fundamental Math while the other must be on a higher level. One of the first problems I encountered four years ago was the fact that for the second year of Math, there was no curriculum, no standardized textbook, no students or teachers attending these classes. The statistics for second year Math were deplorable. Of the three hundred and twenty students enrolled, 150 of them were failing for excessive absence. There were many others who were barely attending 60% of the time. The passing rate in the Regents Competency Math test had reached a low of 37.1%. The attendance rate of the school was 82.4% and the dropout rate was 7.1% In the two and one half years that I have used this new program for the second year of Math, the failure rate because of excessive absence has fallen to only 31 students from an enrollments of 322, the attendance rate of the school has become 87.5, the dropout rate has been reduced to 5.9%, and the passing rate in the RCT has reached 71.4%. Was this rise due to the new course or to other factors? The 119 students who were now attending regularly in the second year of Math translate into a 5% rise in attendance and an 1.1% decrease in the dropout rate. Smith High School has become the third best attended High School in the Bronx. Only Bronx High School of Science and Columbus High School are better. We have the lowest dropout rate except for Science High School. Among Vocational Schools in all of New York City , Smith High School has risen from tenth to second.

All too often, educational innovations have been pronounced successes. Upon investigation, it is obvious that the students and the teachers have been carefully selected to ensure success. In the new course that I introduced, the student population has remained the same. But what about the selection of the teachers who were to implement this course? Let me describe two of the main teachers in the program. One of them was a prime candidate for an unsatisfactory rating because of his attendance (at least 20 days absence a term), poor lessons (two unsatisfactory ratings) and students failure rate (over 50%). The other was sullen, depressed, absent over 30 days a year and reluctant to try anything new. The result in both cases after the new program was introduced was fewer than 5 days absence a year, a high degree of motivation and satisfactory observations. In fact, in one case where I literally forced her to teach the course, she has just taken a study sabbatical to pursue of all things, courses to enhance her knowledge and methods of teaching computer courses.

What effect did this course have among the students? Obviously more of them are attending and passing both the course and the RCT test. The community through these students have become more interested in sending their students to Smith High School. We normally had 1500 applications each year. It has grown to over 3000. The students realize they have a marketable skill. They now can obtain "white collar" part time jobs rather than being relegated to cooking hamburgers or washing cars.

What is this course that has brought about such profound change? When I conceived of it, I knew it had to concentrate on three major areas. First, the students had to learn the "hard topics" of arithmetic: decimals, percents, fractions and verbal problems. Secondly, they had to become intelligent consumers since nothing, I feel, perpetuates poverty as much as a lack of intelligent use of an individual's resources. And lastly, the students had to become computer literate in order to survive in today's world. In Related Tech Math I, which I have now formalized into a calendar of lessons (available upon request), there are 40 class lessons covering wages, overtime. gross wage, net wage, withholding taxes, straight commission, credit charges, mortgage payments. simple interest, compound interest, adjusted gross wage and taxes (Federal, State and City Income). There are 30 computer room classes in which the students learn to read, operate and design a spreadsheet. They normally start with a tutorial disk and move to copying prepared spreadsheets on their grades and baseball averages. From these, they begin to construct spreadsheets on net pay, charge accounts, commission, and mortgage installments. They finally arrive at designing their own for the purchase of a car. By selecting options, credit charges, and installment payments, they learn the various commands for formatting and editing a spreadsheet. They learn to use various formula commands to simplify their computations. In short, they learn a highly technical marketable skill.

What meaning does this hold for us? We, as leaders of the educational community, must adapt out programs to reach our students. We have to overcome the normal student distractions such as the Cosby Show, Duck Tales, violence and sex which permeates the lives of our television couch potato students. They are waiting for their day in paradise and we must provide them with the motivation, incentive and opportunity to reach it. Are we going to feed the flames of educational famine and allow it to go on and on? Or are we going to take up arms by preparing ice pellets to quench the fire which was always burning since the world's been turning? This is the problem which we, as leaders, must address.

TECHNOLOGY AND VALUES VISIT THE PATENT AND TRADEMARK OFFICE BICENTENNIAL

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Introduction

You have an idea for a product or process. If you tell someone about your idea, the idea may be stolen. If you don't tell about your idea, others cannot reap the benefits of your improvement or improve on your idea. Stalemate.

Intellectual property law is an effort to regulate the sharing of ideas--not simply to protect inventors. The U.S. patent system was designed as much to enhance invention as to aid commerce.

The 1990 bicentennial of the American patent system is an opportune moment in history to see how the Patent and Trademark Office has influenced the direction of science, technology, and commerce. A history of efforts to develop intellectual property law is a history of efforts to develop public policy for creativity. The point at which the inventor's desire for commercial protection meets the public's need to know technology so as to build on it, is a potential point of conflict, and is a place where science and technology meet cultural values.

Definitions

American patent law provides for several types of protection which should be understood before exploring the philosophy of patenting in greater detail:

Utility patents have a seventeen-year term and are granted to protect "new, useful and not obvious processes, machines, compositions of matter and articles of manufacture." Patent examiners understand that no invention is likely to be an entirely new concept. Technology is incremental, and usually a patent application identifies an "improvement." Furthermore, the invention must be capable of some beneficial use and not be frivolous.

Design patents have been available in this country since 1842. They can be sought by anyone who has invented a new, original, and ornamental design for an article of manufacture. "Ornamental" implies that the patent covers the appearance of an item rather than the concept. Design patents are granted for a period of up to fourteen years.

Plant patents for new varieties of asexually reproduced plants have been available since 1930. "Patentable plants must have been reproduced by means other than seeds, such as by rooting of cuttings or by grafting" (Burge, p. 9). Plant patents have a term of 17 years.

Trademark refers to a wide variety of different commercial marks. A trademark can be a word, name, symbol, or device used by a manufacturer or seller to identify a product and is indefinitely renewable.

Trade secrets are undisclosed formulas, patterns, devices, or compilations of data used in one's business that provide an economic advantage over competitors. Trade secrets cannot be discovered by "reverse engineering" and are truly "secret." They may not be protected by a patent. Protection is governed by state law. Trade secrets have no time limitation. The disadvantage to the public is that they are not published like patents and therefore the technology is not available for study and/or application by others.

History of Patent Law

Although we have no evidence that the development of the wheel or the invention of fire were patented, we do know that early Greek civilization developed a great many scientific advances including the water clock, the lever, surveyors' instruments, and the catapult as a weapon. The governing body of Athens granted "franchises" to those who invented new products (Skolnik, p. 15).

The first record of an official patent rewarded the inventor with a three-year monopoly on his barge fitted with a hoisting gear. That was by the Republic of Florence in 1421. By 1550 the Republic of Venice had granted more than 100 patents under its 1474 patent law. The Doge of Venice granted Galileo a 20-year patent in 1594 on a "machine for raising water and irrigating land with small expense and great convenience" (Jones, p. 4).

Before 1790, many of the American colonies and states granted patents. The first was granted by the Massachusetts General Court in 1646 to Joseph Jenkes for a salt manufacturing mill (U. S. Department of Commerce . . ., p. v). American colonists sometimes went to Europe to record inventions. Such was the case with British Patent no. 401, granted in 1715 to Thomas Masters for "a new invention found out by Sybilla, his wife, for cleaning and curing the Indian corn growing in the several colonies in America." British Patent no. 403 was also granted to Sybilla Masters for "working and staining straw for hats, bonnets, etc."

On April 10, 1790, President George Washington signed a bill which created the original American patent system. Since then American patent law, and the philosophy on which it is based, has been reexamined and rewritten many times.

To Patent or Not to Patent

> Congress shall have power . . . to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries.
>
> U. S. Constitution, 1787

Interestingly, this paragraph, which was the foundation of the 1790 patent legislation, did not mention commerce, profit, or monopoly. The motivation of the founders was "progress of science and the useful arts." It lays the foundation for a compromise between those who opposed protection for intellectual property and those who favored protection.

The American patent system has two primary purposes. It provides the inventor with a limited monopoly, giving the owner the right to exclude others from making, using, or selling the protected invention for a specified period of time. At the same time, it assures that the relevant technology is available to all. Once a patent is granted, it can be read by any interested person; thus it gives the inventor an opportunity to profit while it systematically releases new technological information to the public.

This quid pro quo situation did not always exist. Early objections to patents were that they constituted an unfair monopoly and concentrated wealth. Similarly it was argued that, when their technology is not fully described, patents stifle scientific progress. Many scientists preferred an open system of publication, arguing that ideas--especially advances in science--should not become private property and should not be used for profit. Marie Curie is a classic example.

> My husband, as well as myself, always refused to draw from our discovery and material profit. We have published, since the beginning, without reserve, the process that we used to prepare the radium. We took out no patent and we did not reserve any advantage in any industrial exploitation. No detail was kept secret, and it is due to the information we gave in our publications that the industry of radium has been rapidly developed (Curie, p. 225).

Nevertheless, the argument that technological progress is enhanced with pecuniary incentive prevailed again and again. Creativity may or may not have its own rewards, but the "purchase" of a patent is a commercial investment. Inventors showed their support for patent systems by using them.

In 1559, for example, Giacopo Acontio, an Italian, applied to Queen Elizabeth for a patent on furnaces and "wheel-machines." He feared that unless his ideas were protected, others would copy his inventions to his loss. He argued that "those who by searching have found out things useful to the public should have some fruits of their rights and labors" (Jones, p. 12). Acontio's reasoning is said to have led to an English policy of rewarding inventors with patents.

Another objection to patent laws has been that they would be administered capriciously and that not all members of society would have equal access. Examples are taken from early British law where patents for inventions are but one type of "letters patent." Such grants, made by the crown, included honors, gifts of land, and liberties. During the reign of Charles II, patronage and monopoly were closely linked and patents were granted to regulate trade and manufacture (MacLeod, p. 20). Patents were often issued as rewards or favors to enhance the welfare of supporters. Although administered quite fairly, even now British patents are granted by the crown and are considered a privilege, not a right, of the inventor.

Although modern American (and international) patent law has been improving in its fairness, a notable exception can be seen in the special case of American slaves.

American Slavery--A Special Case

Oscar J. E. Stuart, a white planter in Mississippi wrote to Jacob Thompson, Secretary of the Interior, on August 25, 1857, about patenting a valuable invention created by his slave, Ned, who had constructed an innovative cotton scraper heralded as "a great labor saving machine." With the assistance of "one man and two horses it could do the work of four men, four horses, two single scrapers, and two ploughs." Stuart requested the patent for himself as owner of Ned and therefore owner of Ned's invention (James, p. 4). The parallel between "real" property and "intellectual" property is noteworthy at this point.

The Commissioner of patents argued that because Ned was not a citizen, he could not receive a patent for his invention. Stuart, argued the Commissioner, was clearly not the inventor and therefore could not receive a patent. On June 10, 1858, the Attorney General concurred with the Commissioner, ruling that inventions by slaves could not be patented. The consequence, of course, was that such intellectual property did not enjoy legal protection or formal recognition. The ruling stood until the passage of the 13th and 14th amendments.

Brothers Joseph and Jefferson Davis attempted to receive a patent for a slave's invention of a propeller specifically designed to maneuver river steamboats in shallow waters. The patent denial was based on the 1858 Attorney General's decision. When Jefferson Davis became president of the Confederate States, he established legislation that permitted a master to receive patents for the inventions of his slave "and have all the rights to which a patentee is entitled by law" (James, p. 10).

Significantly, these cases point up the fact that the slave owners wanted to use the patents for commercial profit, yet were not reluctant to give the credit for the innovations to the true inventors. Indeed, Stuart entered the business of manufacturing and selling Ned's cotton scraper and advertised it as the invention of a slave.

Intellectual Property as Commercial Property

The philosophical and legal vagaries of patent law become meaningful in its application. Intellectual property, under modern patent law, can be used as real property. Intellectual property in the form of a patent can be used for profit by using it directly, renting it, or selling it.

All or part of a patent can be sold or assigned. For example, Margaret Knight was the first to find a way to fold and seal the bottoms of paper bags in one operation--an invention that surely changed shopping habits. An independent inventor, she had a choice to use her patent in any way she wished. Her 1879 patent for the Paper-Bag Machine was assigned to the Eastern Paper Bag Company--presumably for a fee. Similarly, Edwin Strain assigned one half of his 1896 "Art of Making Split Needles" patent to Helen Blanchard, herself a prolific inventor of items relating to sewing machines, who was a manufacturer of sewing machines and attachments.

A patent can be rented or licensed. For example, Dorothy Rodgers, who protected the concept of her "Jonny Mop" with a utility patent and protected the name of her device with a trademark, chose to license her patent to Johnson & Johnson for a royalty to be paid on every "Jonny mop" sold.

Many inventors have profited handsomely from their inventions by selling the product of their invention directly to the public. Controversy over profits surrounded the one-piece flannel Emancipation Union Suit patented by Susan Converse in 1875. Feminist groups wished to lower the price of this garment in order to bring the benefits to greater numbers of women. The inventor

> replied that she "intended to use any invention for profit," and thus would not forego the 25 cent royalty she earned on each garment sold. Indeed, she asked, with all your zeal for women's rights, how could you even suggest that "one woman like myself should give ofher head and hand labor without fair compensation?" (Warner).

Inventions which endure are normally those which earn a profit for their inventor or for a sponsoring organization. DuPont has invested heavily in Stephanie Kwolek's Kevlar invention only because large profits are expected.

Epilogue

Patent law has influenced the direction of science, technology, and commerce. Although the motivation of American patent law was "progress of science and the useful arts," clearly commercial interests have been the driving force behind the patent system. And yet we see a system that has found a reasonable compromise between those who oppose protection for intellectual property and those who favor protection.

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A PROGRAM DEVELOPMENT PLAN FOR INTEGRATING ETHICS INTO THE ENGINEERING CURRICULUM: AN INNOVATIVE COLLABORATION BETWEEN CHEMICAL ENGINEERING AND STS

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Emerging from the social upheavals of the 1960s and 1970s, the field of Science, Technology, and Society (STS) presently faces the challenges of program development and outcomes assessment as it becomes a mature field. If programs are to illustrate the social values of technology, we must strive for a multiplicity of perspectives which extends beyond traditional disciplinary boundaries (Cutcliffe, 1989). The degree to which STS programs affect their institutions must be judged by methods designed to measure effectiveness and report validity (Mentkowski and Loacker, 1985). When the challenges of program development and assessment are successfully met, faculty and students benefit by an articulated program development plan that regularly reports its impact to students, other institutional faculty, and accreditation agencies. As the assessment results are employed, the program's aims become increasingly well defined and its faculty become better able to address these aims.

The following paper outlines a program development plan in which STS issues are addressed within an engineering major. The program is presently administered by interdisciplinary faculty in history and policy studies, chemical engineering, and technical writing at the New Jersey Institute of Technology (NJIT). Beyond NJIT, there is a national acknowledgement that the engineering curriculum itself needs reform (Johnston, Shaman, and Zemsky, 1988; American Association for the Advancement if Science, 1989; Landau, 1989). Even though there has been no drop in the demand for entry-level engineers, there has been a surprising decline in freshman interest in engineering over the past six years (Green, 1989), a situation suggesting that the field is unable to attract majors. Perhaps a broader introduction to engineering as a career in needed.

Background to the Program

While the STS program at NJIT exists autonomously, over the past two years faculty were invited to integrate the program's analytic orientation into undergraduate courses in the College of Engineering. Recent program development recognizes that the 139 required credits for a degree in engineering leave little room for electives and that even these electives do not give students a sufficient opportunity to understand technology as a complex social process.

At both the institutional and the national level, there is indication that students will benefit from an STS orientation to their own field. The benefits of this approach will enable students to explore key issues--the social construction of knowledge, the significance of value studies, the importance of technical translation--and apply them to their major. At a practical level, the total number of credit hours within a major will not be increased. At a theoretical level, students will be called upon to apply a humanistic, contextualistic frame of reference within designated engineering courses, thereby strengthening their commitment to the interdisciplinary program and its values.

A Program Development Plan

Figure 1 illustrates the STS program development plan as it is presently being developed in the Department of Chemical Engineering, Chemistry, and Environmental Science at NJIT (Lewandoski, 1989):

Figure 1. An STS Program Development Plan for Chemical Engineering

Courses	Academic Emphasis	Range of Knowledge	Writing Assignments	Desired Outcome
Level 1 (Sophomore) ChE 224: Chemical Process Principles I	Experiential	Students explore their own perceptions in relation to the field of chemical engineering.	To draw on the experiential response of students to the field.	To allow students to investigate their academic interests and professional goals.
Level 2 (Sophomore) ChE 226: Chemical Process Principles II	Disciplinary	Students explore the role of the chemical engineer in the workplace.	To promote an attitude of inquiry about the field.	To allow students to investigate the role of the engineer in the workplace.
Level 3 (Junior) STS 330: Engineering as a Profession	Disciplinary/Interdisciplinary	Students explore the historical, cultural, and ethical dimensions of engineering.	To allow an understanding of forces affecting the field.	To allow students to understand the role of the engineer as influenced by the historical, cultural, and ethical focus.
Level 4 (Senior) ChE 472: Process and Plant Design ChE 488: Chemical Engineering Laboratory II	Societal	Students explore the role of the engineer in society.	To ensure the ability to communicate competently and to think critically.	To allow students to articulate expertise, to solve problems traditionally, and to solve problems creatively.

Yoked to two semesters of introductory courses in the analysis of chemical processes, ChE 224 and 226 are one credit courses offered in the fall and the spring of the sophomore year. A designated elective offered in the junior year, STS 330--Engineering as a Profession--is a three credit course. In the senior year an STS faculty member team teaches two capstone courses, Plant Process Design (ChE 472) and Chemical Engineering Laboratory II (ChE 488), with chemical engineering faculty.

The program is based on three basic concepts. First, the program promotes an increasing level of academic sophistication. Encouraging students to reflect on connections between their own experiences and their professional choices is commonly viewed as a way to help students achieve a necessary commitment to their field. Beginning with this emphasis in ChE 224, the program increases its academic demands: institutionally-based research is stressed in ChE 226, disciplinary and interdisciplinary analysis is stressed in STS 330, and professional communicative competency is stressed in ChE 472 and 488. As students progress through the program, they encounter an increasing awareness of the complexity of the engineering profession; they begin to understand their roles as potential leaders in their profession.

A brief summary of each course will show how this theoretical framework is executed.

Level 1: ChE 224

In this first course ethics is defined for the students as a value-oriented system concerned with the rational adjudication of moral questions and the establishment of norms (Bechtel, 1988). Discussion in this course focuses on the framework for the analysis of ethical theories developed by Abraham Edel (1961): students are asked to consider the strategies by which their field functions and advances, the ways that professionals function within specific institutions, the dominant dangers of the field, and the control possibilities of these dominant dangers. To help students develop an ethical framework, the course employs a case study focussing on Roger Boisjoly, an applied mechanics engineer who worked on the space shuttle Challenger. Beginning with Bosijoly's own narrative given at the Massachusetts Institute of Technology on January 7, 1987, the case study employs a series of memos and FAX messages written in the period before the Challenger's explosion on January 28, 1986. Richard Feynman's recollection of his experience with the Rogers commission is also used (1988). From this case study, students learn to explore such subjects as the inevitable value-laden nature of technology and its communication. Stressed also is the necessity of testing ethical theories within practical situations as a way to develop ethical awareness.

Level 2: ChE 226

In this second sophomore level course, students explore the range of careers in their field. Discussion focuses on the history of the profession in its key developmental areas: the beginning of unit operations by A.D. Little (Reynolds, 1983), the connection between chemical theory and engineering practice by Allan P. Colburn (Hounshell and Smith, 1988), the view of chemical engineering as a model profession during World War II (Brockman et. al, 1970), the view of chemical engineering as an environmentally unresponsive profession in the 1960s and 1970s (Carson, 1962), and the current emphasis on chemical engineering as a globalized and interdisciplinary profession (Landau, 1989). Applied value studies are encouraged as guest lecturers discuss government regulations.

Level 3: STS 330

This junior level course, planned but not yet taught, will include emphasis on the public image of the engineer (Petrosky, 1985), engineering in the corporate culture (Meehan, 1981), value studies (Martin and Schinzinger, 1983), and risk communication (Johnson and Covello, 1987).

Level 4: ChE 472 and 488

In the first capstone course, Process and Plant Design, students are asked to design a plant which yields 1500 tons per day of ammonia. Areas of emphasis include design considerations, material balance, creation of a process flow diagram, equipment pricing, comprehensive economic analysis, and environmental issues.

In the second course, offered with ChE 472 in the last semester of the senior year, students perform experiments on a Non-Adiabatic, Non-Isothermal Reactor, a Tubular Flow Reactor, Distillation, and Extraction. In each case, students are to set the background for the experiment, the process of its execution, a discussion of the findings, and a conclusion.

Taken together, these two courses epitomize the highly diverse work of the chemical engineer. Capturing the engineer's task of applying scientific principles and practical judgment to problems concerned with human welfare, ChE 472 and 488 allow students to show their ability to contribute to the solution of specific technical problems as well as to the solution of such compelling social problems as conservation and environmental control.

Outcomes Assessment

At the present writing, outcomes assessment procedures have taken place on Levels 1, 2, and 4 of the program.

Level 1: Exploring Chemical Engineering

To enhance the experiential emphasis of ChE 224, a final paper allows students to define and explore their field. Students are asked to describe how they came to major in the field and what areas held their interest most. As well, students are to discuss opportunities and responsibilities in their career path and to establish goals both as a student and future practitioner of chemical engineering. Students are given opportunities for both peer and instructor comment on their drafts.

After submission of the final papers, faculty from STS and ChE select sample papers, draft criteria, and evaluate each paper. (For the assessment methodology involved, see Elliot, Plata, and Zelhart, 1990.) A 6 point scale is employed, with a score of 6 as the highest and 1 as the lowest. Since each paper is read by both STS and ChE faculty, a total score of 12 is possible. Significantly, faculty from both departments score the papers similarly: both STS and ChE faculty average identical mean scores of 3.96 ($r=.5810$, $p<.05$). Overall, the combined overall score is presently 7.92 ($N=25$).

Level 2: Case Study of A Chemical Engineer

In ChE 226, an NJIT graduate currently employed in the chemical engineering industry is the subject of a case study. Students are to identify aims of the interview, select an interview methodology, summarize the interview, analyze information from the interview, present a summative portrait of the engineer, and suggest directions for further research. Using the same scoring methods used in ChE 226, interdisciplinary faculty evaluate the papers in agreement, producing no discrepant scores. In addition, the mean score on these papers recently rose to 8.56 ($n=16$). Significantly, the outcomes assessment plan has captured that which is most difficult and most sought in program development: a reliable and valid measure of the improvement of student performance.

Level 4: Capstone Presentations

In both ChE 472 and 488 students give oral group project presentations to faculty from STS and ChE. Presentations are scored according to criteria focusing on both general educational goals and professional engineering goals. At the present writing, data analysis is promising: a relationship has been found in the scoring criteria among individual items and among these items and overall performance. Shortly, we will be able provide faculty with brief, statistically derived criteria for future capstone evaluations. Because the presentations were videotaped, a brief training session will also be possible for future capstone assessments. Based on a discriminate analysis model, the capstone outcomes assessment plan will allow faculty to identify the experiential, required, traditional, and creative skills students achieve. Once identified, instruction in these skills can be promoted throughout the undergraduate major.

Conclusion

The program development model presented here has been especially rich for faculty and students at NJIT. In stressing interdisciplinarity, faculty have extended their own training in order to achieve a student-centered program responsive to the call for attention to value studies. Instead of pandering to students by reducing expectations about academic performance, the program has intensified demands in order to create an environment that encourages students to pursue their major with the rigor it deserves (Green, 1989). An integral part of the program, our outcomes assessment plan allows us to trace, quantify, and report the progress of our students to local, regional, and national audiences. By employing the results of the various levels of assessment within the curriculum, our program becomes an iterative model in which outcomes are used to refine the curriculum.

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COMPUTER APPLICATIONS IN TEACHING ENVIRONMENTAL SCIENCE

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The requirements in the general education core at Iona College include one semester courses in mathematics and computer science and a two semester sequence of four modules in Scientific and Technological Literacy (STL). These STL modules are chosen from the themes of health, energy, and the environment. Each week, the student attends two one hour classes and a two hour laboratory[1,2].

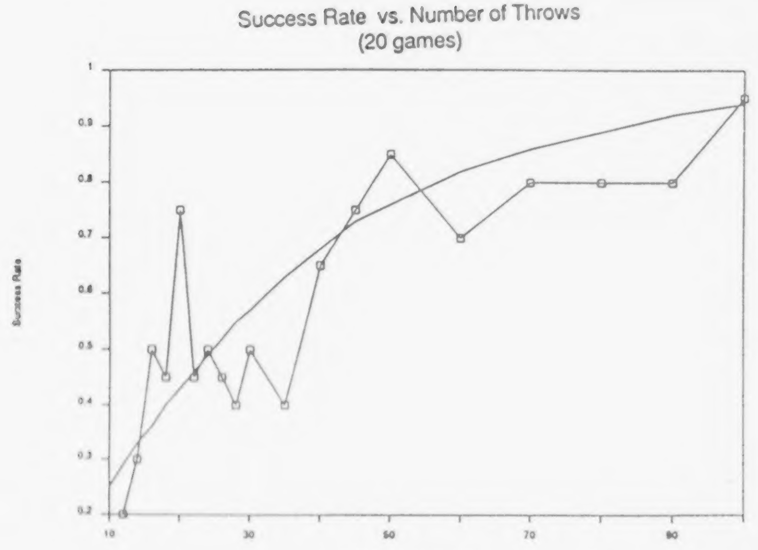
The computer applications presented in this paper were developed in the final half semester module of the environmental theme. This particular theme develops assessment skills in both lecture and laboratory settings. These assessment skills include decision making, forecasting, and transferring of information from a model form to the real world. A computer executed dice game is used to develop decision making skills and concepts of probability. A sequence of laboratory experiments studies the detection of lead in the environment; an atomic absorption apparatus interfaced to an IBM computer is used in the final experiment.

Computer Model for Probability and Decision Making

Most decisions regarding the environment are based on experimental evidence. At best, this evidence is usually incomplete; the scientific and technological input into the decision making process is only one of several other considerations. To aid in the decision making process, the experiments are performed to determine environmental patterns. Decisions are made based on the extrapolation of those patterns which can affect millions of people. The scientific reasons which cause the pattern may or may not be determined by the time the decision has to be made.

A computer generated dice game is played to illustrate a process which mimics the environmental decision making scheme. Two dice are thrown a number of times. If two sixes appear, the student wins; otherwise, the computer wins. On any one throw of the dice, the probability for getting two sixes is one out of thirty-six. The number of throws that the student is allowed can be varied. For instance, a student can have ten chances or throws to win; or fifteen throws; or any number of throws. The problem is to find the number of throws that would permit a 50% success rate. Most students initially believe that eighteen throws would give an even winning percentage. A class (approximately 25 students) then plays the game on the computer. Each student plays the game ten times; with a sample of 250 games, the winning percentage is usually far less than 50 %.

This leads to a discussion on the design of the experiment to determine the number of throws needed for 50 % success. Also, the dependence of winning percentage on number of throws is also sought. The number of throws is varied between 10 and 100 and twenty games are played for each number of throws. The results are placed on a spreadsheet



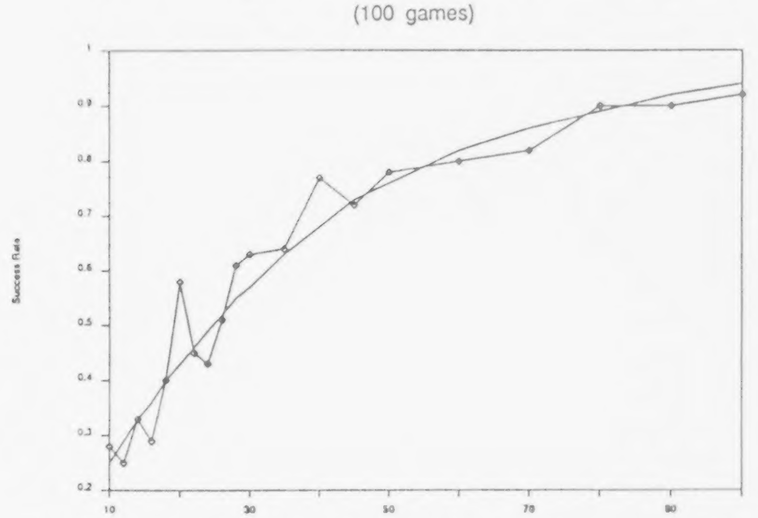


Figure 1. Success rate as a function of the number of throws. The smooth curve is the theoretical plot. The top graph presents typical results after 20 games; the bottom, after 100 games.

(such as LOTUS 1-2-3) and they can be easily plotted using the graphics software. Typical results appear in Figure 1.a. The winning success rate appears to increase as the number of throws is increased but the result is not a smooth increase. The games are then repeated for 100 times at each throw (Figure 1.b.); the pattern appears to become smoother.

At this point, a theoretical discussion of probability takes place. The students have already been exposed to concepts of probability in an earlier mathematics course, but except for the math major, the average student has forgotten most of what was attempted to be taught.

The dice game mentioned, is an example of a repeated random event. The outcome of any one throw is impossible to predict, but the pattern for a number of throws can be forecasted. The two variable which the student can choose are the number of throws (n)

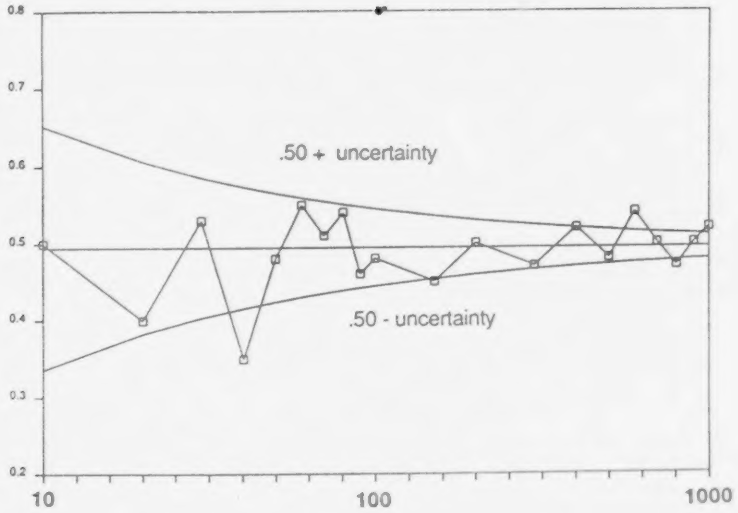


Figure 2. The success rate for 25 throws. The numbers of games was varied from 10 to 1000. The straight line indicates the average of all the results. The uncertainty is theoretically predicted.

and the number of times the game is to be played (N). Using rates which vary from 0.00 to 1.00, the success rate (p) plus the failure rate (q) equal 1.00; or

$$p + q = 1$$

or

$$p = 1 - q$$

Determining the success rate after n throws is a rather extensive sum or terms; but, a failure after n throws means that a failure occurred on each of the n throws. The success rate for 1 throw was mentioned as 1 out of 36; the failure rate for 1 throw is thus 35 out of 36. The failure rate after ten throws, for instance, means that each of the ten throws was a 35 out of 36 case, or $(35/36)^{10}$. The failure rate as a function of the number of throws is thus

$$q = (35/36)^n$$

The success rate after n throws then becomes

$$p = 1 - (35/36)^n$$

The theoretical plot of the success rate is the smooth curve in the Figure 1 graphs.

The graphs of Figure 1 seems to indicate that the more times the game is played, the closer to the theoretical the results become. This leads into a presentation of the concept of expectation values and experimental uncertainty.

If p is the success rate for n throws, then the number of wins after playing the game N times is Np. The uncertainty in the expected number of wins is calculated to be $(Npq)^{1/2}$. The success rate then become (Number of Wins)/(Number of Games), or

$$\text{Success rate} = (Np)/N$$

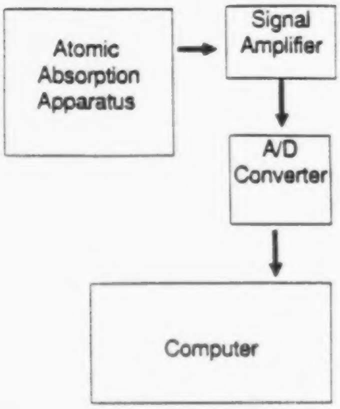


Figure 3. Block diagram of the Atomic Absorption apparatus interfaced to a computer.

This, of course, is just p. The uncertainty in the success rate is (Uncertainty in Number of Wins)/(Number of Games) or

$$\text{Uncertainty in Success rate} = (Npq)^{1/2}/N$$

This becomes $(pq/N)^{1/2}$. Thus, as the game is played more and more times, the actual success rate should approach the theoretical rate by the inverse square root of the number of games played. Students pick a certain number of throws, such as twenty-five. They can then play the game between 10 and 1000 times or more. Figure 2 contains the results of one such data determination. The experimental data with the average rate and the variation of the uncertainty is plotted. The experimental data follows the variation that is expected.

Computer generated data is especially useful in testing decision making models and developing concepts of probability. The theoretical can be illustrated by data generated by the commands of the student. Large amounts of data can be conveniently handled and presented in graphical form rather easily.

Computer Interfaced Atomic Absorption Apparatus

The laboratory segment of the module analyzes the presence of lead in the environment. In the five laboratory sessions, the students analyze the presence of lead qualitatively and quantitatively using wet chemistry methods. Their determination of the least amount of lead that can be detected by sight leads to an analysis using an atomic absorption apparatus. At this stage, the student can analyze the presence of lead in water to one part per million and the student is using a research grade piece of apparatus. Since the procedure involves calibrating the instrument using known samples and comparing the results to unknown samples, several steps are repeated in the procedure.

Using commercial software (ASYST) and a 12 bit analog to digital converter, the atomic absorption apparatus was interfaced to the atomic absorption apparatus (Figure 3). An interactive procedure was written in the software which allows the user to input information about the known samples. The computer program converts this to a calibration equation. In measuring an unknown sample, one hundred experimental points are taken. The information returned gives an impurity level along with the experimental uncertainty of the measurement. A printer can also give a hard copy output of the results.

The sequence of experiments develops several concepts. The student realizes that good experimental data is difficult to obtain. Using a sophisticated instrument enables the student to move beyond the human senses in obtaining quantitative results. Since repeated measurements yield different results, the concept of experimental error is experienced within the lab. Knowing a value along with its uncertainty makes decision making a very important and human task.

Conclusion

The uses of the computer in this module have provided new opportunities in learning. The development of concepts in probability and decision making have become more experiential and will make a more lasting impression on the student. Using a sophisticated research instrument connected to a computer has given the student in a general education core course the experience of using an experimental method which is at the cutting edge of the technology.

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AN STS COURSE FOR BUSINESS STUDENTS

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ABSTRACT

The three-credit Commercial Systems course at Iona College is part of the Scientific and Technological Literacy (STL) program and attempts to demonstrate the relationships that exist between science and business. It is the second course in a sequence. In the first course, students study the basic scientific concepts underlying matter, energy, life, and systems, and engage in the development of reasoning and problem solving skills characteristic of scientists and engineers. In the second course, the roles that scientific analysis, scientific knowledge and technology as vital tools in management decision making in business are emphasized. Business related case studies that demonstrate that science and scientific methods are components of typical business decision making problems are used.

The first half of the course attempts to answer the common student complaint of "What does science have to do with my business major?" The emphasis is placed on demonstrating that modern business is driven by scientific advances and their technological applications as much as by management and marketing techniques.

The second half of the course emphasizes business forecasting as a systematic process. Students learn to use the computer in developing statistically based forecasts and building models. They are taught to identify scientific discoveries as the source of new technologies, to assess developments in science and technology, and to make decisions with incomplete data and uncertain knowledge.

Introduction

The three-credit Commercial Systems course at Iona is part of the Scientific and Technological Literacy (STL) program and attempts to demonstrate the relationships that exist between science and business. It is the second course in a sequence. In the first course, students have studied the basic scientific concepts underlying matter, energy, life, and systems, and have been engaged in the development of reasoning and problem solving skills characteristic of scientists. In the second course, the roles that scientific analysis, scientific knowledge and technology as vital tools in management decision making in business are emphasized. Business related case studies that demonstrate that science and scientific methods are components of typical business decision making problems are used.

Iona College's Scientific and Technological Literacy (STL) program, a multi-faceted and interdisciplinary effort, is designed to impart the analytical skills and knowledge of scientific methods needed by the educated and concerned citizen to meet today's scientific and technological challenges. All arts and business students, as part of their general education core requirements, are required to complete the STL sequence. Each sequence consists of two courses, each a semester in length, focusing on one of four themes: health, energy, environment, commercial systems. Since faculty from the biology, chemistry, physics and psychology departments share the teaching assignments in STL, the students are exposed to different viewpoints on science and technology with problem solving and the systems approach acting as an integrating factor. Each class meets for two lecture hours per week and for a two hour laboratory activities session.

The major difference between the present STL program and previous offerings in science for the business and liberal arts student is the emphasis placed on process as opposed to content. In addition, the activities component in each module (each course consists of two modules) provides a "hands-on" experience for the students which helps them develop an appreciation for the role of experimentation in science.

Each theme of four modules seeks to achieve the same goals, although the subject matter may be different. In the first module, the emphasis is on problem solving, with an accompanying review of basic and necessary scientific concepts and terminology. The systems approach involving concepts such as input, output, information, feedback and control is used. The concept of a model is central. Scientific content is introduced in terms of the illustrative examples used in each theme. Fundamental scientific models of matter, energy, and life are developed in class and reinforced in outside readings taken from textbooks, magazine articles, newspapers, and scientific publications. The second module, constituting the second half of a three credit course, continues the development of science and technology in a vertical structure. More models and rudimentary simulations are introduced. Quantitative methods are introduced along with some general characteristics of technology.

Simultaneously in the laboratory, students are learning to make basic measurements, collect data, analyze it and use models derived from simple introductory, biological, chemical, and physical experiments. Elementary hypotheses are formed, tested and results are presented in tabular and graphical form. Scientific measuring skills, computational skills, graphing, reasoning, and critical thinking are emphasized in the first two modules.

Emphasis in modules three and four across themes is on decision making and assessment. Topics involving cost-benefit analysis and risk-benefit analysis are introduced. Technology assessments in formal and informal applications are considered. Values and their role in ethical decision making are treated. Complex decisions involving open-ended problems are analyzed in examples such as kidney transplants, genetic engineering, and radioactive waste disposal. The accompanying laboratory activities increasingly rely on the computer as a tool for analysis. (7)

Commercial Systems

Part I - Science, Technology, and Business

The first half of the course attempts to answer the common student complaint of "What does science have to do with my business major?" The emphasis is placed on demonstrating that modern business is driven by scientific advances and their technological applications as much as by management and marketing techniques. Examples such as the automobile industry and the information technology industry: computers, telecommunication devices, etc. are considered in order to detail the role of science and technology in developing new products and services and the applications of technology in improving daily operations including manufacturing and management. For example, the role of science and technology in dictating engine designs, microprocessor control units, new alloys and the use of plastics is cited. The use of robots, bar codes, laser scanners and computers in the production process is noted. The role of technology in helping solve problems posed by government regulations, fuel efficiency, safety, labor costs, and durability is highlighted.

After defining cost-benefit analysis and risk-benefit analysis, students are sensitized to the fact that each new technology comes with costs and problems. Not only must new technology be analyzed in terms of obvious first order benefits but also in terms of secondary benefits. What are the costs associated with each? Students then pick a technology winner from a list of companies. Information about the company must be obtained from newspapers, magazines, newsletters and other sources. Twenty-five thousand dollars are invested on a particular day and one month later, sold. The profit or loss is computed and turned in along with a rationale for purchasing stock in the company. The report must include a description of the major products or services and the technology used or produced by the company.

Next the physics of electricity is studied to provide the scientific understanding of technology that develops from its application. Electron flow, conductors, resistors, simple currents and storage cells are studied. In addition, A.C. induction, D.C. induction, power generators using steam, fossil fuels, or nuclear power are considered. Electric power transmission systems, grids, and transformer losses and hazards are also treated. Having acquired a basic understanding of electricity, several case studies involving the business of electric power from a consumer's point of view and then from a producer's point of view are studied. Students having studied and compared incandescent and fluorescent lighting systems in terms of light, heat, power, and costs are asked to analyze the feasibility of using light saver devices in a motel chain in terms of costs and benefits. They basically study the application of a technology from a consumer's point of view. The producer's view is considered in a case study on decision making for a public utility in terms of its generating capacity and rate structure.

Another case study involves the biotechnology industry. After once more studying some basic science involving a discussion of genes, proteins, bacterial physiology, and genetic engineering, students are able to understand how the pharmaceutical industry may use technology involving bacteria as protein factories. The students trace the production of a product from the lab to the marketplace accompanied by appropriate activities in the laboratory.

Part II - Business Forecasting

The second half of the course emphasizes business forecasting as a systematic process. Students learn to use the computer in developing statistically based forecasts and building models. They are taught to identify scientific discoveries as the source of new technologies, to identify knowledge needed from other fields of study, to assess developments in science and technology and to make decisions with incomplete data and uncertain knowledge.

After defining forecasting and a forecaster's job, the art and science of forecasting is developed in a qualitative and quantitative fashion. Time line and branching diagrams are treated in class and the lab. Examples such as HDTV and superconductivity and their possible effects on business are considered. Students are taught to build simple quantitative models that involve assigning values to possible outcomes so as to obtain a weighted formula or model that will allow them to evaluate various outcomes. The example of selecting a job is treated by assigning weights to such attributes as: salary, location, benefits, etc. and constructing a formula that will assign scores to various jobs allowing one to choose the best opportunity. The advantage of using a spreadsheet for situations involving many variables becomes obvious and the students are asked to do so.

Time series forecasting is treated using a program, AUTOCAST II, which averages out short term irregularities using an exponential smoothing technique. (4) They learn to use the program to produce forecasts, graphs and reports.

Trend analysis is used to try to understand how a trend moves through time. Built on graphical analysis, trends can be divided into linear or cyclical patterns. Forecasters or futurists use trends to create superior scenarios involving interactions between trends. Using a spreadsheet, databases can be explored to identify trends.

The role of probabilities in the decision making process are treated. First the fundamental laws of probability are reviewed in terms of a computerized dice game. (5) Since no one can be certain about future outcomes, probabilities must be discussed. A number of examples that are taken from the NLA NEWS (published monthly during the academic year under the New Liberal Arts Program of the Alfred P. Sloan Foundation) are used involving the best plan for investment, auto accidents, and nuclear power concerns. The elements of decision making, i.e. criteria, constraints, optimization and modeling, are treated in several activities. First, a game involving pattern recognition and optimization is used. Given eighteen matches with the constraint of being allowed to pick up one, two, or three matches over time, what strategy must be used to avoid picking up the last one and losing? What is the winning strategy? After determining that working backwards gives the quickest solution, is it possible to generate a formula that will work for any number of matches and a maximum number of picks? The process of dynamic programming is thus introduced. Decision trees as applied to risk assessment is also considered. If a child is bitten by a strange dog, should the child be treated for rabies? Using a spreadsheet can one determine whether one should go to court and sue or settle out of court? (1,2,3)

The delphi method and its application to decision making is also considered. One example treated is that of the problem of auto emissions. Four policy choices are given: addition of an anti-pollution device, limitation on number of cars sold, rationing gas, and raising gas prices. Each policy is then subjected to a series of questions that the student groups must vote on while conducting the delphi analysis such as chances of success of the policy, public acceptance of the policy, political support, long term success, economic effects, and chances of enforcement. (6) Elementary statistics and its application is reviewed and applied to situations such as nuclear power plant safety.

By the end of the course student projects again focus on picking a technology winner in which they must use three forecasting techniques in their solution to identify the best companies for investment.

In developing our students' quantitative capacity and compensating for deficiencies in quantitative ability, we have placed a major emphasis on incorporating exercises that require our students to use computer application packages as tools in problem solving and decision making. The chief priority is the development of skills in using quantitative methods, and their applications to real-life situations. Such skills allow students to seek relationships within large amounts of data and interpret graphical results in a quantitative fashion.

By treating business problems that have technological and scientific content, in a systematic way, the hope is to lead business students to recognize the value of science and technology as tools in managerial decision making. In addition, they learn the value of fundamental quantitative and computer techniques that may aid them in assessing technology and in making decisions.

COMMERCIAL SYSTEMS

Part I - Science, Technology, and Business

1. Introduction: Technology in Commerce and Industry
2. Analyzing Technology - Cost/Risk-Benefit Analyses.
3. Assessment - Technology Assessment and Government Regulations.
4. Introduction to Case Studies, Physics of Electricity, Energy and Power.
5. Electric Power Generation and Transmission.
6. The Business of Electric Power; A Consumer's Viewpoint; Case Study of the Ajax Motels.
7. The Business of Electric Power: A Producer's Point of View; Case Study of Utility Decision Making Concerning Building Generating Capacity and Setting Rates.
8. The Commercial Potential of New Electric and Lighting Technologies.
9. The Biotechnology Industry I: The Biology behind the Business.
10. The Biotechnology Industry II: The Biology behind the Business.
11. Commercial Applications of Biotechnology.
12. From the Lab to the Marketplace: A Look at Selected Biotechnology Companies.

Laboratory Activities

1. Analyzing Commercial Aspects of Technology: Picking a Technology Winner.
2. Measuring Electrical Quantities: Current, Voltage, Resistance.
3. Electric Lighting: Efficiency and Cost Considerations: Comparison of Incandescent Light Sources.
4. Photovoltaic Cells: Electricity Directly from Light.
5. A Lighting Survey.
6. Bacterial Growth.
7. Discussion and Analysis of Technology Winners Assignment.

Part II - Business Forecasting

1. Introduction to Business Forecasting.
2. Visionary Forecasting: Time Impact Diagrams and Scenarios.
3. Quantifying Futurecasting Attributes.
4. Time Series Forecasting - Exponential Smoothing Technique.
5. Trend Analysis - Evaluating Forecast Accuracy.
6. Probability and Decision Problems
7. Elements of the Decision Making Process
8. Core Study - Future of Nuclear Power and Technology

Laboratory Activities

1. Constructing Branching (Time Input) Diagrams.
2. Using Autocast II.
3. Probability.
4. Pattern Recognition and Algorithm Formulation.
5. Decision Trees - Risk Assessment.
6. Delphi Technique.
7. Project Presentation.

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Dr. Victor A. Stanionis is an Associate Professor of Physics and Curriculum Director of Iona College's Scientific and Technological Literacy program. He has been teaching at Iona since 1961 and has been involved with the development of the STL program since its inception in 1977. He coordinates the curriculum of the STL program and is responsible for seeking funding from outside sources for its development.

BUSINESS FORECASTING BEYOND SPREAD SHEET

Ming Huang, Iona College, New Rochelle, NY 10801, (914) 633-2236

Most business decisions depend on some kind of forecast. Forecasts are intended to predict the quantity of something, the timing of some event, or probability of some event occuring. Until recently, forecasting was done by specialists who have knowledge in statistical analysis and mathematical modeling and by mainframe computers. Today's powerful PC can handle all but the most complex forecasting tasks. There are a number of good software packages that allow experts as well as novices to forecast with exceptional ease.

Computing - on mainframes - first entered the business curriculum in the early 1970s and was taught in the computer science department. Until the 1980s, however, microcomputers were virtually nonexistent in business schools. Then, the integration of computing into the business school curriculum proceeded with lightning speed. Many schools have created their own introduction to business information systems. Most such courses tend to put heavy emphasis on problem solving with spreadsheet and database-management programs. Though people have different opinions regarding the extent to which students should become skillful users of applications software, conceptual understanding of the algorithmic process is generally considered more important than technical proficiency, such as how the software can be used as an aid to decision making in the business world.[1]

AUTOCAST II is an expert forecasting system.[2] It can be used to handle many different types of business data such as sales revenues, cash flow and expenses, prices, etc. on a daily, weekly, or monthly basis. The forecasts are based on an analysis of trends and seasonal cycles within the historical data. The program uses statistical decision rules to determine the types of pattern that gives the best fit to the data. Forecasts are then computed by an exponential smoothing technique which is favored as the most general approach for most problems because it requires less data and is easiest to fit to a particular model. This sophisticated, fully menu-driven software can be run in an automatic mode (default) in which all smoothing parameters are selected by an automatic search algorithm. This allows even novice forecasters to be able to analyze historical data and develop useful business projections. All one has to do is feed the data into the program, the system will test the data for seasonality, choose an appropriate model, and then produce the forecast. On an EGA monitor, the forecast plot displays different colors for actual data, fitted data, and the forecast. The available summary reports are well designed and provide model-fitting data, fitted values, error and trend figures, and forecast values. However, the program's utility really becomes apparent when it is run in manual mode. By choosing the parameters option, one has a wide range of modeling, simulation, and analysis choices. The system makes it easy to test different forecasting models and to select the most appropriate one. For sophisticated users, the program allows control over the full range of statistical methods used, including probability distribution, confidence limits, variance analysis, and auto-correlation analysis, as well as a full range of data transforms.[3]

Iona's Scientific and Technological Literacy program has a theme in Commercial Systems in which the role of technology, and scientific knowledge and analysis as vital tools in business managerial decision-making are emphasized. One of the objectives is to teach students to recognize business forecasting as a systematic process in which statistical analysis of business data is applicable. Statistics traditionally is taught with emphasis on theory and definitions of statistical concepts rather than practical application to ordinary business decision making. As a result, students often fail to apply statistics when the need arises. Further few remember the techniques. However, the state of the art computer software makes statistics much more accessible to people who work with quantitative information on everyday business problems. While Lotus 1-2-3, a popular software program, can be used to analyze business data for statistical purposes, the program is not particularly geared for forecasting. As a highly flexible program, it requires skills from the user to set up the spreadsheet which means macro programming as well as background in statistics. As a result, students generally turn away from computers owing to lack of skills. By executing AUTOCAST II in the automatic mode, students need only to enter data and the system will do the rest. In the beginning, students have a two-hour hands-on laboratory session where the main features of the program are introduced and illustrated. After a few exercises, the average student usually can use the software without experiencing a great deal of frustration. It has been my experience that hands-on exercise leaves a lasting impression and the ability to start using the software package right away definitely has a positive impact in the learning process. Once the students feel comfortable using the program, they can quickly make new discoveries and speed up their learning curve as a result of the user-friendly operating format and a relatively well-written user manual. Sample data files are made available to the students and assignments require them to be able to edit data, select models, forecast, simulate forecasts, generate graphs and analysis reports, and interprete the results. As the semester progresses, students are required to complete a project of their own choice using AUTOCAST II and give an oral and written report at the end of the semester. I found some of the principal advantages of the software are as follows:

1. The program is versatile, simple to use, and very easy to learn.
2. The program has the capability to access Lotus files directly.
3. Reports and graphs can be created easily.
4. The program is a valuable instructional aid to teach the concepts and techniques in statistics.
5. It can be a stepping stone to other forecast software and future employment situations for the students.
6. The program has a student version available for classroom use at a very nominal rate. Upon purchase one receives documentation and license to distribute as many copies as required for classroom use.

"Today, the power behind a desk has a lot to do with the power on top of it." The computer is an indispensable tool to aid the management in business forecasting and decision making. The computer's capability for generating, accessing, and managing information, can be used to transform both day-to-day practices and long-term planning. The most important technical preparation may be a conceptual understanding of how computers can reorder and revolutionize work processes. However, it's important to remember that no forecast is ever 100 percent accruate. The user must use his or her judgment in concert with the computer-generated forecast results to refine the predictions. At the same time, it's easy to make monumental mistakes in judgment. Although it's impossible to forecast without judgment calls, one should try to make the forecasting process as objective as possible. AUTOCAST provides ways to quickly try alternative models and compare the results which make the predictions more objective and less a case of just guessing about the future. As a result, the decision making is much better and simpler.

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SCIENCE LITERACY AND LIBERAL LEARNING: A PROGRAM INVOLVING STS ISSUES

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Unprecedented attention, from local to national levels and from kindergarten through graduate training, is being directed to science education these days. Such attention has various foci ranging from the nation's anticipated shortage of scientists and engineers to the general public's knowledge of and attitudes towards science. The special concern of this discussion is the role of collegiate education in promoting scientific literacy in all students. It is proposed that in meeting the challenges of attempting to achieve widespread scientific literacy that at least some of the problems inherent in general attitudes toward science and increasing the numbers going on professionally in science will also be addressed.

The decline of student interest in science at the college level is well documented (Green, 1989). Mathematics interest among freshmen is only about one quarter what it was twenty years ago. Interest in the physical sciences is about half of what it was. The life sciences have held constant over a twenty year period but is now only half of what it was during a period of peak interest in the early 70s. What these data do not reveal is the reason or reasons for the declines.

Another disturbing realization, apparently familiar on all campuses, is the further erosion of interest in science following students' initial experiences with science courses in college. Here again more information is needed before drawing conclusions such as the obvious possibility of ineffective teaching.

Student evaluations at Wesleyan University of science courses for non-science students and courses intended to be introductory to science majors, both show the erosion of interest. The varied negative opinions of students regarding these courses seem to cluster in four general areas. These can be roughly categorized as follows: a) science tends to overemphasize rote memory of facts; b) science is irrelevant or strange, difficult to comprehend and, hence, is a source of "science anxiety"; c) science is abstract and even inhumane, hence, it is boring or simply "not for me"; and d) science is for those who like its exotica and problem-solving, hence, another version of "not for me." This brief catalog does not refer to that minority who do enjoy science and for whom none of the foregoing comments is applicable.

These perceptions need to be placed alongside a view of liberal learning - the most typical tradition for collegiate education in the United States - and a view also of scientific literacy so as to place the problems of science education (at least in its initial collegiate phases) in a more explicit context.

Regarding liberal learning, there must at the onset be reiterated the truisms of all education because they are so important. In essence they are two-fold. First, all of us start our lives as arational, unfeeling, amoral entities, i.e. we start from zygotes which go on to develop epigenetically into embryos and fetuses, and then are born as babies which continue to develop through infancy and childhood into young adults and beyond. The appearance of cognitive and affective skills is perhaps the most extraordinary aspect of the ontogeny that is universal among us and learning science is part of that extraordinary process. Second, before we learn science we are, from babyhood on, socialized. That is, we are exposed, among other things, to those pressures that mold us to become active and contributing participants in the communities of which we will become a part. This imbues us with habits of mind, values and attitudes, which set us onto various modes and styles of dealing with ourselves, others, and the rest of the world. Science education must find its place in the midst of all that, too.

College level liberal learning can be viewed as having two essential functions, both derived from the stem-meaning of liberal, namely, to liberate. One function is to liberate learners from their socialized habits, attitudes, and norms in the sense of being empowered to transcend them, should that be deemed desirable. The other is to provide knowledge, skills, and critical abilities that can nurture the learner's development into a self-motivated and liberated person. And again, science education has a place in all of that.

Finally, the last component: scientific literacy. The American Association for the Advancement of Science encapsulates it this way: "...the scientifically literate person is one who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; [who] understands key concepts and principles of science; [who] is familiar with the natural world and recognizes both its diversity and unity; and [who] uses scientific knowledge and scientific ways of thinking for individual and social purposes" (Rutherford, 1989, p. 4).

The complex challenges of college-level science teaching are then a compounding of the individual's developmental progress to fulfill one's cognitive and affective potential while still in the grip of years of socialization. This fulfillment places liberating demands on the learning process, and simultaneously seeks the goals of understanding the interdependent enterprises of science, mathematics, and technology, plus familiarity with their relation to the natural world and their roles in our individual and communal lives. It is a very big order.

A given college program, such as that at Lewis & Clark College, which will be examined here, is constrained by the reality of its resources - staff, physical facilities, and budget - and by its institutional vision of how best to liberally educate its heterogeneous array of students so as to render them scientifically literate.

The key to understanding the Lewis & Clark effort is their Core Program and the contribution made to it by the Science, Technology and Values (STV) Program - their version of what is known nationally as STS. First: What is the Core Program and how does it work in an undergraduate's education? The intellectual essence of the Core is Inquiry and to drive that home all entering students start off with a one term course in Basic Inquiry. This is followed by a single course in Critical Inquiry and one more in Advanced Inquiry, the latter usually taken in the senior year. There are also seven Perspectives in Inquiry courses, usually spread over the freshman, sophomore, and junior years. In sum, there are ten courses required of each student to fulfill each student's core requirements. (This is approximately one quarter of a student's total efforts towards his or her baccalaureate degree.) The theme of inquiry is taken most seriously and is implemented by a sustained effort towards effective writing - an effort carried right through the senior year. This is achieved by extensive writing experiences, both in and out of class. The former is used as a means of getting full participation in classroom ideas as when each student either summarizes or reads in full what she or he has written in response to a class assignment. Outside of class, papers are a common form of homework. For students having difficulties in handling writing assignments there is a Writing Workshop devoted to resolving such problems. The result is a college full of young people able to articulate ideas in effectively organized prose.

The STV (or STS) contribution to all of this is the following. It is most conspicuous in the area of the Core called Critical Inquiry. At the time the Core Program was working its way towards faculty approval there were defined three "mission foci" for the core, namely (as stated in the current catalog of the college), "cross-cultural and international understanding, gender relations, and the relation of science and society." Courses offered in these areas place heavy emphasis on critical analysis, especially in the form of writing. These are obviously interdisciplinary offerings and students are required to take at least one such course. Comparably, they are required to take one Advanced Inquiry course which includes STV offerings. Nevertheless, it is possible, since both Critical and Advanced Inquiry offer many courses and not all are STV in concept, for students to entirely miss any STV courses.

It is, however, not possible, to omit science courses. Of the seven required Perspectives in Inquiry courses, two must be in the natural sciences. It is regarding the nature of these courses that the Natural Science Division Curriculum Committee has spent long hours of discussion and planning during the past year. Before summarizing their current proposals it is necessary to bring in the crucial role that a generous grant from the Murdock Charitable Trust has played in science education at Lewis & Clark over the last two and a half years.

A three year grant (terminating in June, 1990) has been instrumental in strengthening key aspects of science education at Lewis & Clark. The departments of Biology, Chemistry, and Physics have all improved the equipment in their laboratories and classrooms. This has enhanced the opportunities and capabilities for greater student-faculty research. Also there have been funds available to bring in visiting scholars, especially with regard to STV offerings in the Core Program. Other funds have been used to gain released time for faculty wanting to rethink and redesign their current courses and to prepare new courses. In short, this imaginative grant has made possible a variety of educational innovations from hardware to rethinking of traditional efforts to the importation of new ideas.

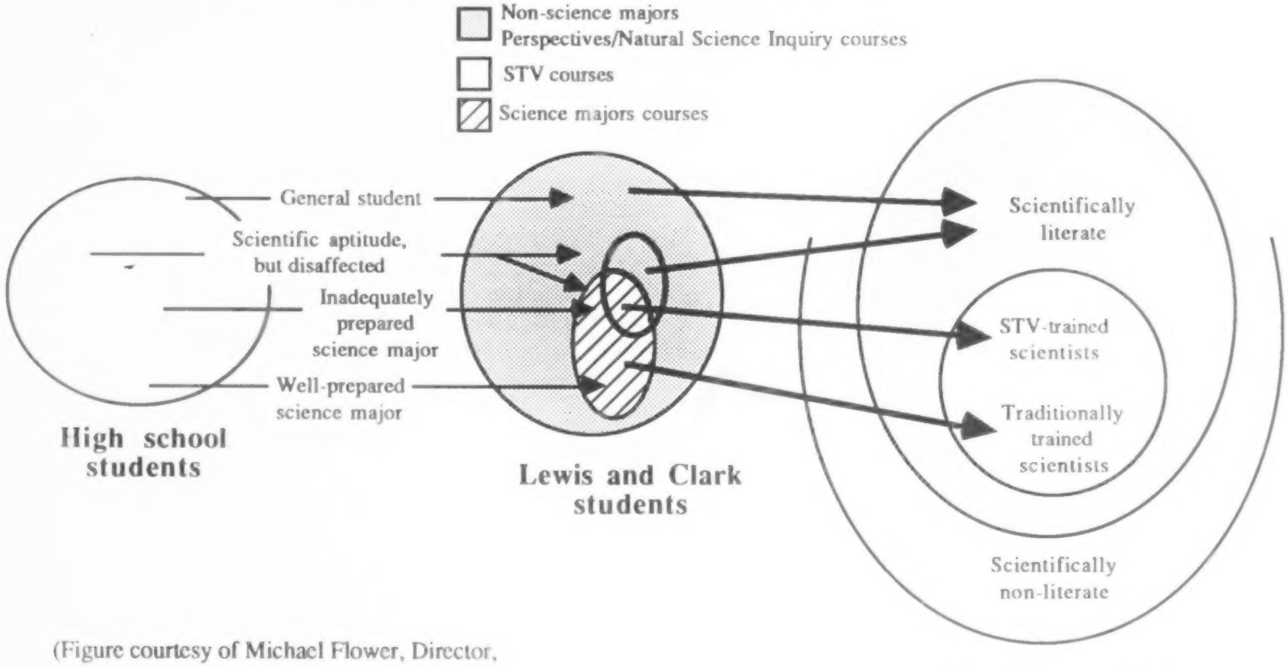
Returning now to the work of the Natural Science Division Curriculum Committee's deliberations, it was apparent that Murdock funds were not only permitting but encouraging the committee to rethink its problems in as fresh and imaginative ways as possible. The present outcome is a proposal sent to the College's Curriculum Committee for, among other things, a recasting of the Perspectives courses to be offered by the Natural Sciences as part of the Core Program. In particular, there will be new courses emphasizing scientific problem solving rather than a survey of what has been solved. Or, as one sociologist of science puts it "science yet to be found" over "science found" (Latour, 1988). This is not a new approach for much of the effort back in the post-Sputnik days, especially those of the Biological Sciences Curriculum Committee (BSCS) at the high school level and the Commission on Undergraduate Education in the Biological Sciences (CUEBS) at the college level, invoked this inquiry-oriented approach. But it is, nevertheless, worthy of renewed attention and can have the addition of contemporary social concerns (STV/STS) added to it.

This will not be a throwing out of the proverbial baby with its bathwater. There is much in the current educational efforts in science by the science professors that is working well, especially as it has been augmented by the current Murdock funds. It is a realization, however, that more needs to be done and can be done. It is aimed directly at the courses that have the heaviest enrollment of students and, more significantly, the courses that will represent the only science courses that some students will take in college and, therefore, their terminal exposure to science studies. These are, of course, the students whose majors do not lie in the natural sciences, and who bring the greatest diversity - alluded to above -

of preparation and attitudes (including robust negative ones) to their appreciation of science.

It is clear that although every student at Lewis & Clark is exposed to the natural sciences (Perspectives in Inquiry) and probably to the ways science, technology, and values interact in our lives (Basic, Critical, and Advanced Inquiry) it is still a great deal to expect that scientific literacy in the sense of Project 2061's goals (Rutherford, 1989) will be achieved. If there is a concise formulation of the minimal expectation for the scientific education of Lewis & Clark's student it is "respect for science." The implication is that even when a student knows that he or she is not going on in science they can understand why some of their peers do elect to major in the sciences and, also, they can respect the role science plays in our lives at this end of the 20th century. Lewis & Clark's science teachers feel that minimal expectation has its best chance of fruition by emphasizing the special nature of scientific inquiry - how science is done, what is distinctive about scientific knowing, what are its strengths and limitations. The self-motivated learner intellectually equipped with that perspective is better prepared to retain and use a respect for science than if they were provided scientific ideas without knowing where they came from and how they might change.

As a maximal expectation for a scientific education there is the case of the science majors. It is hoped that the revised introductory science courses will not only halt the erosion of science interest in first year students but might even arouse latent interest and recruit new science majors. It will be possible to collect solid data on this possibility and such information will be used to identify the more successful of the teaching innovations that are now getting underway. The role of STV courses is to interconnect the inquiry and ideas of science more intimately to the social and individual concerns of not only non-science students but also of the science majors so as to enrich their particular areas of intensive work. This is summarized below.


Non-science majors
Perspectives/Natural Science Inquiry courses
STV courses
Science majors courses
General student
Scientific aptitude, but disaffected
Inadequately prepared science major
Well-prepared science major
High school students
Lewis and Clark students
Scientifically literate
STV-trained scientists
Traditionally trained scientists
Scientifically non-literate
General populace

(Figure courtesy of Michael Flower, Director, STV Program, Lewis & Clark College)

To assess, revise, and rejuvenate science education is a long-haul task as the very name of Project 2061 implies (Rutherford, 1989) and the effort in Lewis & Clark is in the midst of their particular version of that project. If careful thought, careful positioning of new inputs such as the STV Program, and much hard work is a recipe for success, the Lewis & Clark effort is well worth watching.

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NON-MAJORS DESERVE "REAL STUFF" IN THEIR SCIENCE COURSES

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Introduction

What is the most effective approach for educating non-science majors in science? This question has has been the subject of an avalanche of recent reports and discussions (National Science Teachers Association, 1988; Pollack, 1988; Sigma Xi, 1989; National Science Foundation, 1989). A key curricular issue is whether or not non-majors should take science courses designed for science majors or separate courses specifically designed for non-majors. This issue has both philosophical and practical implications regarding the design and implementation of science education for non-majors. Although no consensus has yet been reached on this question, several writers have presented arguments in support of one approach or the other (Westheimer, 1987, 1988; Worthy, 1988; Carlson, 1988; Massey, 1988; Shapiro, 1989). This paper presents a rationale for separate science courses for non-majors and describes two proven approaches to accomplish this.

Science Education for Non-majors - Need

Science education for all persons is important when considering the ideals of the liberal education and the pragmatic issues of jobs and the economy. Implicit in a liberal education is an understanding of oneself in relation to the many facets of human experience. An understanding of the natural world, one such facet, empowers people to deal rationally with life's challenges. Science contributes to this understanding. The application of science, or technology, also has a huge impact on human society. People's understanding of their world depends heavily on their scientific and technologic literacy.

Citizen involvement in decision making is essential to the democratic process. An increasingly large number of public policy decisions are based on scientific and technological issues. Citizens are deciding, either through deliberation or default, crucial local and global issues. For example, decisions are made regularly affecting waste management, energy generation and availability, and maintenance of the environment. Scientific and technologic facts and awareness are needed for a thoughtful analysis of these and many other issues. **Science education for all citizens has profound implications for the future of this country and the world. A citizenry that understands science and its nature and is not intimidated by science is better able to investigate and resolve scientific and technologic issues.**

Repeated claims have been made that **the key ingredient** to global economic competitiveness is an educated workforce (Thurow, 1989; Cyert and Mowry, 1989). Thurow provides compelling arguments that an educated workforce, and not more capital, better technology, or more abundant natural resources, will determine the course of the global economic wars. In a technological society such as ours, an educated workforce is one that is knowledgeable in science and technology.

Several recent surveys conclude that the American public is scientifically illiterate (Mullis and Jenkins, 1988; Hively, 1988; Culliton, 1989). These results show that none of the goals of science education for non-majors - understanding of the natural world, informed decision-making on scientific issues, and preparation of an educated workforce - are being accomplished. These failures are cause for grave concern to the United States and its citizens.

Science Education for Non-majors - Historical

Science requirements for non-majors have been reduced dramatically over the past several years (Mallow et al., [1988]). Today only six to seven percent of the total number of credits, or roughly two-three credit courses, in the typical baccalaureate degree are devoted to science (Westheimer, 1987, 1988; Mallow et al., [1988]). Increased science course requirements is a mandatory feature of any serious initiative in providing effective science education to undergraduates. Various proposals for making such increases have called for a 9 credit - 3 course requirement (Mallow et al., [1988]), a 16 credit - 4 course requirement (Adams, 1989), and a suggestion that 20-25 percent of the undergraduate program for humanists be composed of science courses (Westheimer, 1988).

A National Research Council Report (1982) stated "the present state of science education for non-specialists is the result of historical evolution that has benefitted the major but left the non-major largely neglected." Until recently, the content of most science courses was directed predominantly toward science majors. The science education of non-majors, the vast majority of students, was underemphasized or neglected. Non-majors were, and in many cases continue to be, treated in one of three ways. They are (1) placed in the same courses as science majors, (2) placed in courses similar to science majors' courses but reduced in content and sophistication, or "watered-down", or (3) placed in science majors courses with some applications "added-on" to build interest. **None of these approaches recognizes the fundamentally different needs of the non-major.**

Separate Science Courses for Non-majors

Marginal treatment of the science education of non-majors can no longer be accepted. This path risks the evolution of a society where persons empowered to pilot it lack the scientific and technological literacy to do so. It is essential to recognize that science education has two main thrusts - majors and non-majors - both important and both with their own separate mission and goals. Shakhashiri expressed this duality at the Tenth Biennial Conference on Chemical Education when he observed that the National Science Foundation has a dual mission with regard to science education: first, to ensure that a competent and constant supply of scientists and engineers is produced, and second, "to see to it that we have an educated citizenry that is supportive - or at least tolerant - of what scientists want to do" (Krieger, 1988). A report from Sigma Xi -

The Scientific Research Society also acknowledges this duality in addressing the question of entry-level courses for science majors and "general students" where general students are described as those "who do not choose to elect the entry-level courses for majors in science, mathematics, and engineering" (Sigma Xi, 1989).

Science majors require comprehensive, rigorous, and up-to-date instruction in scientific principles and concepts. Majors must fully understand the historical development and current scientific paradigms, complete with their mathematical foundations. Science majors take many science courses providing constant content reinforcement. It is common to hear upperclass majors exclaim that they finally understand a concept first introduced in prior courses. This detailed understanding acquired by science majors results from a combination of a high interest in science, intense study, and repeated exposure over several years.

The majority of college students are non-majors who generally complete only a few science courses. Frequently these courses are described by one of the three categories previously mentioned. In these courses students are exposed to much abstract material that is rarely used or reinforced and, therefore, quickly forgotten. Such courses deal only with disciplinary facts and abstractions, fail to provide non-majors with an appreciation of the nature and limitations of science, and do not demonstrate the important role of science in their personal and professional lives. Worse, many non-majors acquire a negative attitude about science from the experience. The result is a pervasive lack of effective science education.

The core of this problem lies in the fact that the science education needs of majors and non-majors are fundamentally different. It is, therefore, unlikely they can be simultaneously addressed in the same classroom. The solution to the problem is threefold. First, the needs of majors and non-majors must be delineated. Second, realistic and effective goals for the science education of both groups must be established. Third, separate courses must be developed for these two groups based on their individual needs and goals. It is important that these two curricular needs -- continual improvement of traditional disciplinary science courses for science majors and the development of science courses for non-majors -- not be combined. **Effective science education for non-majors demands separate courses specifically designed to meet their needs.**

Separate Science Courses for Non-majors - Goals

The overall goal of science courses for non-majors is **scientific literacy.** A scientifically literate person understands (1) the nature and limitations of science, (2) the basic concepts and principles (laws and theories) of science, (3) the technological applications of science, (4) that science is a valuable contributor in the decision making process of the major societal issues of our time, and (5) the uses of scientific knowledge in public policy decisions.

These goals are very different from the traditional goals of **scientific mastery** in science majors' courses. A science major masters a scientific discipline; acquiring a comprehensive understanding of the origin, meaning, and use of the entire disciplinary paradigm. Science majors' courses therefore deal in science while courses for non-majors deal in science, about science, with applied science (technology), and with the societal, policy, and human values implications of that science and technology.

To illustrate the fundamental distinction between scientific literacy and scientific mastery consider the thermochemistry of hydrocarbon combustion reactions, a topic treated in typical introductory chemistry courses. In majors' courses where mastery is the goal, the topics of equation balancing, reaction stoichiometry, thermodynamic equation analysis, Hess' Law treatment, and bond enthalpy calculations are treated quantitatively and in detail. For non-majors, where literacy is the goal, the nature, balancing, and qualitative thermochemistry (exothermic) of the equation would be discussed. Further, the role of hydrocarbon combustion in society, the global issues created by the reaction products (carbon dioxide, sulfur dioxide from sulfur impurities), and a consideration of the public policy questions such as reduced automobile use, development of clean air fuels, and nuclear power generation would be discussed.

Compared another way, scientific mastery is the ability to read technical textbooks or journals in a scientific field while scientific literacy is the ability to read and understand a periodical article on the same topic such as found in the "Science News" section of the New York Times.

Separate Science Courses for Non-majors - Recognition

Beginning with the National Research Council Report (1982) the decade of the 1980's provided increasing recognition of the need for separate science courses for non-majors. During this decade a Science, Technology, and Society, or STS, movement stressed the need for enhanced consideration of the applications and implications of science in science courses (Roy and Waks, 1985). The National Association of Science, Technology, and Society (NASTS), was founded in 1988 on this platform and currently has almost a thousand members. Sigma Xi - The Scientific Research Society has changed its mission in 1989 to include "fostering worldwide a dynamic and constructive interaction among science, technology, and society" (Morse et al., 1989). As noted earlier, Sigma Xi (1989) has described the "development of entry-level courses for the general student" as distinct from entry-level courses for majors. The President of Princeton University, Harold T. Shapiro, has declared that "Teaching science to non-scientists is a national challenge" (Shapiro, 1989). A faculty committee at Princeton convened to investigate this issue reports that "non-science students are not always well served by taking courses that are designed primarily as introductory experiences for potential majors" (Shapiro, 1989). During the past two years separate science course in biology (Carlson, 1988), chemistry (American Chemical Society, 1987, 1989; Nelson, 1988), and interdisciplinary science (Oxtoby, 1987; Sigma Xi, 1989; Adams et al., 1989) have been described.

Separate Science Courses Non-majors - Approaches

In view of their different goals, it is logical that the course format for non-major's and major's courses be different. Two innovative formats currently being used for non-major's courses are the issues approach and the thematic approach. In the issues approach the course is organized around several major issues and the disciplinary content unfolds as needed to understand them. Issues are selected to ensure they interest the intended audience and permit development of the full range of scientific fundamentals. The ChemCom chemistry course developed by the American Chemical Society for secondary schools (American Chemical Society, 1987; Nelson, 1988) uses the issues approach. During the development of the issues students are exposed to the major concepts of chemistry, their technological applications, and the public policy implications of this science. The success of ChemCom has given the American Chemical Society (1989) additional impetus in developing a College ChemCom course partly based on the success of the secondary version

At Babson College, a four year business college in Massachusetts, an issues approach course titled "Chemical Technologies in the Manufacturing Process" is being taught to upper level students. The course revolves around the four issues of materials science, energy, waste management, and the chemical industry. The first three issues comprise the components of the manufacturing system - starting materials are transformed into products through energy use with the generation of waste. These issues are most appropriate for business students and they provide the opportunity to discuss the fundamentals of chemistry. The fourth issue, the chemical industry, allows the discussion of an industry called the best industry in America (Dertouzos et al., 1989). In addition, much descriptive chemistry can be introduced if the top ten raw materials produced by the chemical industry are studied.

The thematic approach develops the course around themes rather than disciplines and is, therefore, necessarily interdisciplinary. Such an approach has the same goals for the science education of non-majors but they are packaged differently. Both one-semester (Adams et al., 1989) and two-year (Oxtoby, 1987; Sigma Xi, 1989) thematic interdisciplinary courses in science education have been described. It is interesting to note that these courses have a similar theme -- the evolution and fundamental similarity of all matter and life in the universe.

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WHOM TO HEED IN THE EXPERT SOCIETY: A COURSE FOR COLLEGES AND UNIVERSITIES (AND MAYBE HIGH SCHOOLS, TOO)

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The course outlined below derives from five years of research into the phenomenon of "expert status." Expert status denotes that measure of authority that we grant to individuals based on our impression that they have specialized knowledge, skill, and experience that may help us. This course applies concepts from sociology, anthropology, linguistics, and social studies of science to the question of expert status.

Below, I describe briefly the notion of expert status as a negotiated, provisional status. Second, I lay out the course in four segments listing major concepts to be covered and suggesting appropriate readings for the class or for instructor preparation. I also propose class exercises. Third, I have attached an annotated bibliography covering the suggested readings.

The Negotiation of Expert Status

Expert ability differs from expert status. The office of "expert" represents a provisional social status negotiated in interaction between technical and nontechnical people.

This inescapable negotiation involves a relative specialist, who is a candidate for expert status, and someone who is effectively a client consulting the specialist for help in making a decision. Interaction between specialist and client, although ostensibly for the transfer of information, in reality represents the conduct of a relationship. In this relationship, specialist and client jointly negotiate meaning and social identity. The client, in attempting to evaluate whether the specialist has something credible and relevant to say, gauges the person, the specialist, as much as the utterance. The client jointly selects whom and what to heed.

Through negotiation, the specialist can achieve a measure of authority that I call "expert status." Expert status reflects achievement of an authoritative rank vis a vis the client. The client grants this edge in status based on understanding of the discourse and social structure of an issue-based community. This "issue arena," like other types of communities, has within its permeable boundary class stratification and interest group conflict.

In presenting this interpretation, I am engaging in an exercise in "discourse design." Use of the term, "expert status," compels reconsideration of the role of the "expert" in modern society. This new perspective emerges from a combination of insights from literature in sociolinguistics, the philosophy and politics of language, community and ethnic group studies, and social, legal, and symbolic anthropology.

In the study on which this course is based, I illustrate my points through ethnographic analysis rooted in three years of observations of a local water board concerned with toxic waste issues. I develop a theoretical framework intended to link the feelings of disenfranchisement of the relative nonexpert to cultural understandings of occupational affiliation, status, and the ritual nature of relationships between specialists and clients.

Course Segments

I. Experts and Decisionmaking Processes

The first segment of this course introduces questions surrounding the role of "experts" in modern society. Works to be read and discussed in this segment are both reflective pieces by anthropologists and fictional works outlining our expectations of "experts."

Student assignments can include writing a descriptive piece on an encounter with a specialist of some kind. Alternatively, students could interview one another about such an encounter and write a piece based on that interview. This latter alternative develops a student's skills in interviewing and empathizing and helps classmates become acquainted.

A quick exercise involves having students count references to "experts" in newspapers or radio or television news. This exercise will give students some idea of how much we take for granted the social institution of "expert."

Readings: Baum (1966), Douglas (1982), Gluckman, ed. (1972), Tolstoy (1988).

II. Where Have We Seen This Sort of Activity Before?

This second segment of the course illustrates that scientific "experts" are not the only kind of specialists that people consult. Readings for this segment cover the practices of traditional African diviners and healers contrasted with modern, scientific practitioners. Each type of society selects its own brand of specialists and develops expectations about their powers.

For this segment, bring to class a folk specialist and a scientific specialist (not necessarily on the same day). Folk specialists include palm readers, psychics, healers, witches, trance mediums, water witchers, and the like. After this sort of class interview, have the students do a little research of their own and write an analytical piece drawing parallels between some aspect of the practice of a traditional, nonscientific specialist and a modern "expert."

Readings: Achebe' (1959), Colson (1973), Delillo (1985), Evans-Pritchard (1937), Horton (1967), Lan (1985), Luhrmann (1989), Marwick, ed. (1982), Park (1963).

III. Putting Things in Context -- Communication Between Technical and Nontechnical People and Community Structures, Norms, Relationships, & Status

Communication between technical and nontechnical people occurs and becomes problematic when someone consults a specialist. Problems arise when the person facing the consequences of a decision begins to feel disenfranchised from the decisionmaking process. This feeling signals a drop in status relative to an "expert." The process by which someone defers to another's expert status resembles other forms of status bias. A multi-ethnic community, such as a modern American city, serves as a good model for the stratification and interest group conflict that occurs on "technical" issues such as toxic waste, or AIDS, or nuclear arms.

Readings for this segment illustrate parallels between multi-ethnic communities and issue arenas. Strathern (1982) and Clifford (1988) describe the concept of a negotiated status. Caesar-Wolf (1984) and Hughes (1958) discuss just what it is that is negotiated when a specialist negotiates for expert status (Caesar-Wolf focuses on a witness in a courtroom, whom I see as akin in many ways to a specialist who is being consulted by a non-specialist; both witness and specialist presumably know something that someone else wants to know).

Students can write a short paper describing a modern workplace that each one selects to visit. The workplace should be described as though it is a community or a part of a community. The student should focus on informal relationships, as in a community, that help workers to do their jobs rather than on an organization's explicit hierarchy.

Readings: Caesar-Wolf (1984), Clifford (1988), Glaser (1972), Hughes (1958), Ibsen (1963), Mitchell (1956), Philips (1987), Strathern (1982), Van Maanen and Barley (1984), Vidich and Bensman (1968), Walker (1987).

IV. Critiques of Modern Practices -- Macro->Policy, Micro->Workplace

By this stage, students should be ready to view familiar issues with a new perspective. They can now attempt to identify struggles for expert status that are masquerading as arguments about technical issues of substance. They should be able to address mundane events as well as spectacular ones. Everyday, workplace activities provide understanding that helps in analyzing major policy debates (and vice versa).

In the readings and activities for this segment, have students list cues that help to identify a specialist, and have them characterize specialist-client relationships. Try to get them to describe dissonances in specialist-client interaction and to delineate status biases, status hierarchies, "community" divisions, and "community" norms.

A traditional exercise for this segment would be to have students write a critique of a modern issue debate to outline the status games being played. More creative exercises involve production of videos or writing of short stories in which the issues developed during the term are depicted graphically.

In class, students can engage in role playing. They can imitate that old television game show where three contestants are quizzed by a panel to see which one actually has the occupation that the quizmaster initially describes. One of the three contestants can be thoroughly briefed on the occupation while the other two fake their bids for expert status based on what they learned during the quarter. Students can, alternatively, imitate a show where "experts" are interviewed concerning an issue of local concern.

Readings: Hawkins (1984), Meehan (1984), Riemer (1976), Waddell (1989).

Outcomes

Students should come away from this course with a good idea of how we in modern society select whose "expert" advice to heed when we make decisions. They should have developed a vocabulary for questioning the process of decisionmaking. They will have skill in critical analysis of a social process from which they might otherwise feel disenfranchised.

This course empowers the nontechnical student and helps the technical student become more circumspect about his or her social role.

Annotated Bibliography

Achebe', Chinua (1959). Things Fall Apart. Greenwich, Connecticutt: Fawcett Publications. (Recommended as providing description of traditional African divining practices; compare with modern specialists' activities)

Baum, L. Frank (1966). The Wonderful Wizard of Oz. New York: Dover. (Contains modern society's view of the prototypical "expert," the Wizard)

Caesar-Wolf, Beatrice (1984). The construction of 'adjudicable' evidence in a West German civil hearing. Text, 4(1-3):193-223. (Describes how a person makes a decision based on characteristics of the person talking [here, a witness] and based on what story is being assembled; gives a courtroom version of everyday phenomena)

Clifford, George (1988). The Predicament of Culture: twentieth-century ethnography, literature, and art. Cambridge: Harvard University Press. (Has a chapter on a Mashpee Indians land claims case that conveys the idea of negotiated status, which is what an "expert" gets)

Colson, Elizabeth (1973). Tranquility for the Decisionmaker. In L. Nader and T. Maretzky (eds.), Cultural Illness and Health (pp.89-96). Washington, D.C.: American Anthropological Association. (Short piece that says that in the face of uncertainty, people become comfortable with a decision when they are comfortable with a decisionmaking process; uses example of Gwembe Tonga of east central Africa)

Delillo, Don (1985). White Noise. New York: Viking. (A satyrical novel about a toxic waste spill and a fear-of-death drug, Dylar; deals with modern attitudes toward technical information)

Douglas, Mary (1982). Environments at Risk. In Barry Barnes and David Edge (eds.), Science in Context: readings in the sociology of science (pp.260-275). Cambridge: MIT Press. (Discusses in general terms the role of specialists in characterizing environmental problems in light of a human desire in a variety of societies to believe in a rule-obeying universe)

Evans-Pritchard, E. E. (1937). Witchcraft, Oracles and Magic Among the Azande. (1976) abridged and with an introduction by Eva Gillies. Oxford: Clarendon Press. (Classic piece on practices of specialists [witch-doctors] in a traditional African society)

Glaser, Barney G. (1972). The Patsy and the Subcontractor: a study of the expert-layman relationship. Mill Valley, California: The Sociology Press. (Discusses the negotiations between trades workers and the home-builder who contracts with them in construction work; everyday, specialist-client relationships)

Gluckman, Max (ed.) (1972). The Allocation of Responsibility. Manchester: Manchester University Press. (A series of essays on one of the core issues in decisionmaking; distribution of responsibility is a key factor in the negotiation of a specialist-client relationship)

Hawkins, Keith (1984). Environment and Enforcement: regulation and the social definition of pollution. Oxford: Clarendon Press. (A clear and insightful description of technical decisionmaking in the daily practice of environmental regulation in England)

Horton, Robin (1967). African Traditional Thought and Western Science: part I - from tradition to science. Africa, XXXVII(1):50-71. part II - the 'closed' and 'open' predicaments. Africa, XXXVII(2):155-187. (A pair of classic pieces comparing modern and traditional styles of dealing with the physical world)

Hughes, Everett C. (1958). Men and Their Work. Glencoe, Illinois: The Free Press. (Sociology of work by one of the best; insightful comments on why people act the way that they do in the workplace; comments on issues of status and the meaning of mistakes)

Ibsen, Henrik (1988). An Enemy of the People. Oxford: Oxford University Press. (A play about a doctor finding pollution in a spa that is a town's tourist attraction; addresses the role of an interest group in denying a specialist authority)

Lan, David (1985). Guns and Rain: guerillas and spirit mediums in Zimbabwe. London: J. Currey; Berkeley: U.C. Press. (Sophisticated analysis of the interplay of a traditional style of specialization and a political movement; parallels could be drawn to modern, U.S. society)

Luhrmann, T. M. (1989). Persuasions of the Witch's Craft: ritual magic in contemporary England. Cambridge: Harvard U. Press. (Recommended as an insightful look at nonscientific practices in modern settings; examine to see how a witch gains authority vis a vis clients in a scientific society)

Marwick, Max (ed.) (1982). Witchcraft and Sorcery: selected readings (2nd edition). New York: Viking Penguin, Inc. (A collection of readings on witchcraft and the social role of witchcraft, a nonscientific form of specialization)

Meehan, Richard L. (1984). The Atom and the Fault: experts, earthquakes, and nuclear power. Cambridge: MIT Press. (A case study of decisionmaking under uncertainty involving different kinds of specialists in the siting of a nuclear power plant; relies on participants' stories)

Mitchell, J. Clyde (1956/1959). The Kalela Dance: aspects of social relationships among urban Africans in northern Rhodesia. Manchester: The Rhodes-Livingstone Institute (by Manchester University Press). (Clarifies the role of identity in social interaction; ethnic affiliation in urban Africa has a dynamic resembling occupational affiliation in the U.S.)

Park, George (1963). Divination and Its Social Contexts. The Journal of the Royal Anthropological Institute of Great Britain and Ireland, 93,I:195-209. (A classic piece on the social function of decisionmaking rituals)

Philips, Susan U. (1987). On the Use of WH Questions in American Courtroom Discourse: a study of the relation between language form and language function. In Leah Kedar (ed.), Power through Discourse (pp.83-111). Norwood, New Jersey: Ablex Publishing Corp. (Analysis of how the way that a question is phrased is a reflection of an individual's authority; for example, yes/no questions restrict a responder's reply)

Riemer, Jeffrey W. (1976). "Mistakes at Work:" the social organization of error in building construction work. Social Problems, 23:255-267. (One of the few pieces focusing on mistakes as a routine part of everyday activity by specialists)

Strathern, Marilyn (1982). The Village as an Idea: constructs of village-ness in Elmdon, Essex. In Anthony P. Cohen (ed.), Belonging: identity and social organisation in British rural cultures: Social and Economic Papers No. 11 (pp.247-277). St. John's, Newfoundland: Institute of Social and Economic Research, Memorial University of Newfoundland. (An insightful piece on the nature of a negotiated status; the village described here provides an analogy to the toxic waste arena, for example)

Tolstoy, Leo (1988). Father Sergius and Other Stories ("The Death of Ivan Ilyich"). Moscow: Raduga Publishers. (A witty and telling short story of a bureaucrat dying of an unknown ailment; different doctors offer different opinions)

Van Maanen, John and Stephen R. Barley (1984). Occupational Communities: culture and control in organizations. Research in Organizational Behavior, (6):287-365. (A thorough survey of literature in organizational studies of occupational communities; deals with the internal dynamics of an occupational group)

Vidich, A. J. and J. Bensman (1968). Small Town in Mass Society: class, power and religion in a rural community (revised edition). Princeton: Princeton University Press. (A well known study of what many believed was an egalitarian social unit; fleshes out the concept of community as a divided and stratified structure)

Waddell, Craig (1989). Reasonableness Versus Rationality in the Construction and Justification of Science Policy Decisions: the case of the Cambridge Experimentation Review Board. Science, Technology, & Human Values, 14(1):7-25. (Looks at how publically-made technical decisions really come about; contrasts rationality with the a desire for an ex post facto appearance of rationality)

Walker, Ann Graffam (1987). Linguistic Manipulation, Power, and the Legal Setting. In Leah Kedar (ed.), Power through Discourse (pp.57-80). Norwood, New Jersey: Ablex Publishing Corp. (An analysis of language and power in the status hierarchy of legal interchanges; discusses how a lawyer exerts authority linguistically to control a witness; compare and contrast this forum with other specialist-client interaction; is the lawyer the specialist or is the witness?)

CHEMICALS IN SOCIETY: CHEMICAL EDUCATION FOR THE COMMUNITY AND THE WORKPLACE

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INTRODUCTION

Understanding about chemicals and how they interact with people and the environment is essential to informed citizenship in our society. It is not productive for a society to have its populace react solely on an emotional basis. Rather than anxiously demanding answers, people must:

- learn to ask pertinent questions, obtain evidence and use it as the basis for decision making.
- understand the limitations associated with scientific evidence.
- understand the nature of scientific inquiry in order to participate in formulating effective chemical related policies.

American society must, therefore, educate its populace generally about the nature of scientific inquiry and, more specifically, about chemical concepts and processes. A recent study (SRI International, and the National Science Foundation, 1987) to identify future directions for the role of the National Science Foundation (NSF) in science education in America was commissioned by Congress. The study had the following to say about scientific literacy:

> .... Broad national consensus has developed over the past dozen years that the *most pressing needs* (emphasis added) in K-12 science education lie in the nation's failure to educate the majority of young people to an adequate level of science literacy. Science education, it is argued, should ensure both the public's understanding of science and its ability to cope with the demands that a scientific and technologically dominant society places on it...

The Chemical Education for Public Understanding Program (CEPUP) is contributing to this educational need through the design of activity-based instructional materials for schools, the community, and the workplace. The activities highlight chemical concepts and processes associated with current societal issues. The goal of CEPUP is to develop greater public awareness, knowledge, and understanding about chemicals and how they interact with our lives.

The Chemicals In Society Program is intended for the community and the workplace. It provides materials and techniques for presenting information about chemicals, toxicity, groundwater, hazardous wastes in the home, risk, and understanding parts per million, to non-technically trained community and workplace groups. All of the activities are designed to actively involve the participant in his or her consideration of these issues. Self-instructional participant materials are available for all activities except Toxic Trouble in Fruitvale, so that individuals can be provided with the opportunity to experience any topics that might not be presented in a particular large group session.

The overall goal is to provide individuals with evidence and an understanding of the methods used for collecting and processing information, so that they can participate more effectively in decision-making about issues of concern to them and to their community. We at CEPUP feel that the use of the materials will help make a significant contribution towards improving the "'public's understanding of science and its ability to cope with the demands that a scientific and technologically dominant society places on it" as called for in the SRI report.

The importance of an informed and scientifically-literate electorate may perhaps be made more clear by the following example: an initiative requiring the response and cleanup of *every past detectable chemical discharge* into the groundwater would have a reasonable chance of being enacted today by the voters in California and other states. After all, such a law would reduce risk and improve the quality of the groundwater, and who can be against that? However, the enactment of such a law has its dangers. It would consume a great deal of available private and governmental fiscal and technological resources. This could mean that other problems that pose far greater risks to the community would have to be ignored to meet the requirements of the law. Does this mean that past chemical discharges into the groundwater should be ignored? Of course not; what is needed are carefully planned approaches to determining the risks involved in each groundwater incident in relation to other risks.

In another recent example, a U.S. Environmental Protection Agency (EPA) study based on the findings of technical experts shows that radon, indoor air pollution and pesticide residues pose greater health risks than toxic waste dumps and underground storage tanks do. Yet, the bulk of EPA's money goes to lower-risk problems such as toxic waste dumps. The study goes on to say that "*...EPA's priorities are determined far more by public opinion and its embodiment in statutes than by risk.* [emphasis added]. Despite our findings that the relative risks associated with hazardous waste sites are low, the public clearly fears them and wants them cleaned up..."

The purpose of Chemicals in Society is not to tell the public how to think or act regarding an issue, but rather to provide them with fundamental knowledge, an understanding of useful processes and procedures, and confidence in their own abilities to understand issues and make decisions. As a result the public's decision making regarding chemical-related issues will be based more and more on effective consideration of the evidence instead of an emotional appeal from a variety of advocacy groups.

We at CEPUP realize the materials are likely to be used by and for a wide variety of individuals whose individual goals and objectives may differ somewhat. Therefore, detailed information concerning a Chemicals in Society presentation is provided in the presenter materials, to be used for local adaptation. Included are such topics as: overview and presentation checklist; organization of the materials; a discussion of workshop techniques (including evidence collection and compilation, grouping practices and questioning strategies); discussion guidelines; and a suggested evaluation form. Also included in the kit are suggestions for modifying these general presentation strategies for special groups and to meet a range of time constraints. All necessary chemicals, equipment and presentation aids are included in the Chemicals in Society kit.

SAMPLE ACTIVITY OVERVIEWS

- *What is a chemical?*

We live in a chemical world. Our decisions and actions in this chemical world depend on our understanding of chemicals. Our understanding is based upon at least two considerations: our knowledge of chemicals based on information and evidence; and, our attitudes about chemicals based on our experience. It is important as citizens in a technological society, that we make decisions based upon available evidence as well as personal attitudes. This activity is a survey which evaluates what people know about chemicals and compares this to how people feel about chemicals. We suggest using it as a possible way to start the first session with any community or worker group.

In the activity, participants respond to questions on a chemical survey form which contains both information- and attitude-based questions. After they have finished answering the questions, they compile and compare their individual responses to see how attitudes and information interact when answering questions about chemicals.

- *Hazardous waste in the home*

Many products used in the home such as food, cleaners, polishing compounds, insecticides, and various others, can be hazardous if used in the wrong way. For example, eating a half pound of table salt at once will probably kill some people. This, however, does not make table salt a legally hazardous substance because the probability of anyone eating a half pound at once is very remote. On the other hand, small amounts of salt in the diet of some people can be highly injurious to their health. As frequently stated, the dose makes the poison.

When it comes to wastes, the term "hazardous" does have a legal definition. A legally hazardous waste is a discarded substance whose chemical or biological nature makes it potentially dangerous to people. Although the sale of many products like paint thinners, insecticides, and smoke detectors may require no special warning, the disposal of small leftover amounts or broken devices may be subject to regulation because as a waste they are considered hazardous. This activity highlights issues related to the legal disposal of various household products.

In this activity, participants review a list of products commonly found in the home and select disposal methods they think are appropriate for them. Through discussion they realize that many substances commonly found in the home require special handling when it comes time to dispose of them as a waste. Participants explore and discuss the possible effects on themselves and the community of current and hypothetical public policy decisions regarding hazardous waste disposal.

- *Toxic trouble in Fruitvale*

Groundwater supplies one fourth of the fresh water used in our country. Anyone who uses well water is using groundwater. Groundwater can become contaminated by potentially hazardous chemicals. Often it is not detected until it has spread over a large area. It is difficult to tell the exact shape of the area covered, exactly how fast it will travel, or how fast the contaminant will break down. Information about the amount of contamination can be obtained from special test wells drilled to sample water at given locations. These test wells can only determine the amount of contamination at any given place; they can only provide an estimation of the situation. Frequently, also, our understanding of the health and environmental effects of the chemicals causing the contamination is also limited. Usually we must take some kind of action, in the form of response to a perceived environmental threat, based on limited data.

Toxic Trouble in Fruitvale is a simulation which allows participants to evaluate the source and extent of groundwater contamination from limited available data. Fruitvale is an imaginary town which suffers from groundwater contamination. Participants will use maps and data to determine where the contamination is coming from.and how close the polluted water is to city water supply wells. This simulation can be used to provide an introduction to these ideas. In reality ground water contamination problems are very complex, and deciding what to do about them requires extensive study and analysis.

• *Toxicology*

"Toxicology is the science of poisons. Poisons are substances that are harmful to living things. Paracelsus, the Swiss physician (and alchemist) wrote: 'All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy.' " Toxicity can be thought of as the potential for a substance to be poisonous. The more easily the substance poisons, the more toxic the substance. For example, as stated earlier, table salt, if taken in excessive quantities, becomes poisonous. On the other hand, gasoline is poisonous in very small quantities. It is, therefore, considered to be more toxic. Toxicity is thus the "poison potential" of a given substance.

How do we go about determining the toxicity of a substance? The difficulty is to find out how much of a substance makes it poisonous for human consumption. This quantity, called a threshold level, is determined by standard toxicity tests which are frequently based on the responses of laboratory animals to predetermined doses. In the activity, a group of participants taste drops of salt solution, in very low concentrations, and establish the minimum amount they can taste. The activity is a simulation of a toxicity test.

• *Making decisions*

Many situations in everyday life involve risks. Every act has a certain risk associated with it. We are at risk for actions we choose to take (sailing, bike riding), and for actions which we have no choice about (exposure to air pollution, vulnerability of pedestrians). Our choices are based upon an assessment of the risk involved. This risk assessment is based upon our understanding of the evidence (probability of harm) and our personal definition of what is dangerous. This activity and "RISKO - The Game of Life" introduce participants to the process of assessing and comparing risks.

In the activity, participants read a story about a hypothetical epidemic in their community. Using the hypothetical evidence they are asked to choose between the two available high-risk options. After reacting to the story participants discuss the reasons for their personal decision.

• *RISKO - The game of life*

Many situations in everyday life involve a decision regarding a risk or combination of risks. Many times we react to a risk by taking precautionary measures; frequently we go about our business taking no precautions at all. Almost everyone drives or rides in a car without evaluating each time the various risks involved. At least the majority realize the high risks involved in combining drinking alcohol and driving and so control or eliminate drinking alcohol when they know they have to drive. Unfortunately a significant minority ignore this increased risk, drive while intoxicated, and so increase the risk of death for all other drivers, passengers, and pedestrians. All of life involves comparing the different risks of different actions. "RISKO - The Game of Life" introduces participants to the study of risk and risk comparison.

Participants evaluate a list of 20 common risky activities. They compare risks and select those they think are the highest and lowest. Participants decide which risks they have a choice about and which risks they must accept without choice. Then they compare their selections with available evidence. Through discussion participants learn more about their own risk behavior and risk comparison in general.

- *Parts per million - parts per billion*

We often find reference to parts per million (ppm), parts per billion (ppb), and even parts per trillion (ppt) in our everyday reading and news reports. What does it mean? Most of us have difficulty imagining large numbers of objects. How many stars can you see in the clear night sky far away from the smog and lights of the city? What does it mean when we read in the paper that the salt content of the local water supply is 70 mg (milligrams) per liter? What does it mean when we read that an insecticide has been found in our groundwater at a concentration of 5 ppb? Developing an understanding of extremely large and extremely small numbers is very difficult.

An overhead projector, dropper bottles of food color and water, and a specially developed CEPUP tray (for use with an overhead projector) are used to demonstrate concentrations from 1 part in 10 to 1 ppb food coloring. As the solution of food color becomes more and more dilute, the color intensity decreases, until finally at a concentration of 1 ppm the color is no longer visible. As participants consider that particles of food coloring are present, although invisible, they discuss a naive, but common, misconception—which can be paraphrased by saying "...just because you can't see it doesn't mean it isn't there."

IMPACT AND USE

Chemicals in Society materials have been used by the California League of Women Voters; by the Society of Industrial Hygienists, in Orange and Los Angeles (California) counties; and by staff persons of various California businesses, such as the IBM Corporation and the Hewlett-Packard Corporation, who have incorporated the materials as part of their worker awareness programs and new employee training seminars. Training sessions have been conducted for representatives of businesses in the San Francisco Bay Area and at other locations in California and other states.

Of particular interest to us at CEPUP is the use of the materials by growing number of science teachers to present these concepts to local community groups. Coordinated with various other efforts at developing leadership among local science education faculty, these presentations make it possible for teachers to receive recognition and resultant status which comes from increased visibility outside of the science classroom. Members of the community come to realize and appreciate the tremendous resources available but long-overlooked—namely, the human resources in the form of the science teachers themselves.

Other businesses and industry groups have used the Chemicals in Society materials to prepare a comprehensive public information program as part of their response to the Superfund Amendments and Reauthorization Act (SARA), Title III, nationally, and Proposition 65 in California. These legislative acts require that detailed information about the nature of hazardous substances in or near communities be made available to the public. In these cases, the Chemicals in Society materials are used to provide a basic understanding of science concepts to the general public, especially the non-technically trained. In presentations such as these, specific company content is discussed after an initial experience with the materials.

Chemicals in Society is a major component of CEPUP programs at the University of Barcelona, Tarragona, Spain, and of a planned implementation of CEPUP in Australia, under the leadership of the Royal Australian Chemical Institute. The General Federation of Women's Clubs (GFWC), with sponsorship from the Shell Oil Company, has used an adaptation of the materials called Living With Chemicals, as part of a two year national program on environmental issues for their membership. Using a leader training model, eight regional workshops were held in Fall, 1988, in which over 500 leaders from all 50 states received training and materials. Based on feedback from GFWC membership, over 60,000 individuals have either presented or attended a Living With Chemicals workshop. GWFC has re-adopted the materials as part of a second two-year program for 1990-91.

EVALUATION

Evaluation efforts currently underway include an analysis of feedback, in anecdotal form and from a variety of survey research instruments, from the two-year national adoption and leader training program of the GFWC. Also of interest to CEPUP is an investigation of the nature of the impact of the program on science teachers (and other concerned individuals) who have chosen to present the Chemicals in Society materials to local community groups. All evaluation efforts of the Chemicals in Society materials are being coordinated with similar national studies of the CEPUP school materials. Detailed results of these studies will be released as they become available.

FEEDBACK DESIRED

Chemicals in Society is an ongoing instructional development project of CEPUP. Educating community and workplace individuals about chemicals and the societal issues related to them is relatively new. We expect to revise and add to the Chemicals in Society materials periodically. Your criticism of current materials, suggestions for new materials, and especially information concerning local presentation of the materials will be most helpful in our continuing efforts to improve the program. Please address all comments, suggestions or inquiries to:

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REFERENCES

SRI International and the National Science Foundation. (1987). Opportunities for strategic investment in K-12 science education. Washington, D.C.

United States Environmental Protection Agency. (1989). Comparing risks and setting environmental priorities. Washington, D.C.

Complete Conference Program

ANNUAL MEETING

THE NATIONAL ASSOCIATION FOR SCIENCE, TECHNOLOGY AND SOCIETY

FINAL PROGRAM
for
The Fifth National

Technological Literacy Conference

February 2-4, 1990; Crystal Gateway Marriott
Arlington, VA

Co-Sponsored by:

American Association for the Advancement of Science
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TECHNOLOGICAL LITERACY CONFERENCE - FIVE

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ORGANIZATION

The National Association for Science, Technology and Society (NASTS) was formed in 1988 to bring together the increasing number of persons and groups actively concerned with STS in one way or another.

In some ways, NASTS is a federation of already existing sectors of interest: K-12 educators, post-secondary educators, policy makers, scientists and engineers, public interest organizations, science museum staff, religion professionals, print and broadcast media, and members of the international community. Many individuals working in these sectors have been deeply involved in some part of the STS spectrum for many years.

NASTS' goal is to provide a forum where members of these sectors can gather and take the pro-active stance of guiding technology and science as reflections of our underlying values. NASTS seeks to provide the venue for all its members to meet as equals to discuss, debate and share concerns for society's handling of science and technology.

NASTS is organized as a 501(c)3 non-profit educational corporation. Its president and16 member board of directors, elected by the membership, guides a staff consisting of a Corporation Chair, Member Services Director and Conference Manager. Offices are located at present on the premises of the STS Program at The Penn State University.

NASTS BOARD OF DIRECTORS

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ORGANIZATIONAL

ELECTIONS

In the formative period of the Association, the directors have devised the following system to assure both balance from different communities and a democratic process for selecting leadership. Every year one-third of the board seats will stand vacant and new individuals nominated to stand for election for the 3-year term.

A Vice-President is elected by the members from individuals selected by the nominating committee. The Vice-President will serve as Conference Chair for the next year and succeed to the Presidency the following year.

ANNUAL MEETING OF NASTS MEMBERS

All conference attendees who have paid their registration fee are automatically members of NASTS and are invited to attend the Members Meeting.

Day: Friday, February 2, 1990 Time: 8:30 PM Location: Salon III

AGENDA

1. Welcome by Chair: George Bugliarello, NASTS President, "State of STS in Nation and World."
2. Report by the Corporation Chair, Rustum Roy.
3. Election Results for Board Members and Vice-President.
4. Proposed change in Article 5(3) of the Constitution.
5. Discussion of TLC-6
   a. overarching theme, e.g., "Women in Science and Technology"
   b. suggestions for main speakers, topics, workshops
   c. location
   d. local site visits:
      (1) Thomas Jefferson High School (magnet school); Smithsonian Environmental Research Center; Patent Office; Geological Survey; etc.
      (2) may require additional charges: admission fees, transportation
      (3) arrange for Thursday preceding TLC
   e. role of members in getting TLC symposia funded.
6. Open discussion on initiatives and projects members would like to undertake through the Association.
7. Suggestions for the good of NASTS.
8. Open invitation to NASTS members to attend TLC-6 planning meeting Sunday 1:15 pm.

STS: EDUCATIONAL STONEHENGE OF THE LATE 20TH CENTURY

STS celebrates the joining of human creativity manifest in its science and technology to the larger concerns of human society.

STS takes its name from the three dominating megaliths of the 20th century mindset: Science, Technology and Society. To say "STS" is at once to raise a battle cry without knowing quite what to do. Like fish in water, it is difficult to question that in which we swim.

STS exists under different guises in almost 100 programs in colleges and universities across the country. Almost 2,000 other institutions and schools offer at least one course in STS. Numerous other groups have sprung up in the midst of their respective professions: Society for the History of Science, Social Studies of Science and Society, Society for Philosophy of Technology, the Technology and Society Division of the American Society of Mechanical Engineers, Forum on Physics and Society, and IEEE's Society on Social Implications of Technology, to name just a few.

As an educational movement, STS is concerned with reforming science education for the majority, at the K-12 level, so that it makes real and concrete, "science" which is now abstract and connects it to everyday living.

STS in academia embodies the hope of re-inventing the Uni-versity inside the reality of Clark Kerr's multi-versity. STS infuses scholarly insights from the humanities and the arts to help interpret and manage new discoveries in science and new applications of technology.

Rapidly increasing numbers of citizens all over the world struggle to resolve issues concerning technological options which are unintelligible to the vast majority of us. STS, as the label for this battle cry, is concerned that ALL citizens have the understanding and ability to evaluate technological and scientific activities.

"Everything has changed in our world except our way of thinking."
A. Einstein

SPECIAL EVENTS

"NEW THINKING" ABOUT OUR COMMON PROBLEMS

Four symposia or sessions
Harmonizing
VALUES—SOCIETY—TECHNOLOGY

Science and Technology for Non-technical Majors

Educating citizens and their national leaders (U.S. Presidents, playwrights, CEOs, theologians)

The subtitle forces us to think that educators must focus our S/T education efforts not only on future scientists but on the vast majority (90-95%) of our citizens including most of their leaders, if technological literacy is to have an impact on earth. See next page.

Nuclear Power Revisited

Ten years after TMI, two years after Chernobyl, and at the beginning of the Global Climate crisis, what is "the new thinking" about nuclear power. (See page 9ff.)

The Guardian Project

Radioactive wastes exist in large quantities in our society. The public perceives it as a special and major problem. We must collectively as a society agree on a workable, affordable solution. The concept behind the Guardian Project is genuinely new thinking offering an exchange of "public service" by volunteers in return for high levels of safety. (See page 14.)

The Nummi Experience

Management-labor battles must be replaced by cooperation if U.S. manufacturing is to return to world class competition. The NUMMI experience tells us a great deal about what can be done with some new thinking. (See page 23.)

SCIENCE & TECHNOLOGY FOR NONTECHNICAL MAJORS IN COLLEGE

A symposium supported by the National Science Foundation
Science and Engineering Education Directorate

1:30 p.m. SALON V

SYMPOSIUM INTRODUCTION: "SCIENCE" FOR THE NON-SCIENTIST

John Truxal, SUNY, Stony Brook
Chair, New Liberal Arts Program, Sloan Foundation

FRI 2:30 p.m. SALON K

ENGINEERS AND TECH LITERACY

Moderator: **Russel C. Jones**, University Research Professor, University of Delaware; Past-President, ABET.
David Reye-Guerra, Executive Director of the Accreditation Board for Engineering and Technology.
Wilbur L. Meier, Director, Office of Engineering Infrastructure Development, National Science Foundation.
Curtis J. Tompkins, Dean, College of Engineering, West Virginia University; President-elect, American Society for Engineering Education.

FRI 2:30 p.m. SALON II

DIALOGUE: "SCIENCE" LITERACY AS A GOAL

Morris Shamos and Audrey Champagne

FRI 3:30-4:45 p.m. SALON K

NURTURING NOT WEEDING: A NEW LOOK AT THE UNDERGRADUATE EXPERIENCE

Moderator: **M. Patricia Morse**, Professor of Biology, Marine Science Center, Northeastern University, and President, Sigma Xi.
Anna J. Harrison, Professor Emeritus, Department of Chemistry, Mount Holyoke College.
John Ahearne, Executive Director, Sigma Xi.
Shirley M. Malcolm, Head, Directorate for Education and Human Resources Program, AAAS.

FRI 3:45 p.m. LEE ROOM

WHAT SCIENCE FOR IMPORTANT PEOPLE

David L. Adams, Director of Natural Sciences, Babson College, *"Nonscientists Deserve 'Real Stuff' in Their Science Courses."*
Carl S. Frankel, Assistant Professor of Biology, Penn State University, *"Teaching Science to the Unimpressed."*
Art Rosser, Dean, College of Applied Sciences and Technology, Central Missouri State University, *"Assessing Technological Literacy."*

SAT 12:30 p.m. SALON VI

LEARNINGS FROM TWO MAJOR PROGRAMS: SLOAN (NEW LIBERAL ARTS) AND KELLOGG (AGRICULTURE AND LIBERAL ARTS)

Richard Haynes, University of Florida
Samuel Goldberg, Sloan Foundation

SAT 5:15 p.m. SALON E

STS: MIT AND STANFORD

Learn what is happening in STS at two major universities.
William D. Rifkin, Graduate Fellow, and **Robert E. McGinn**, Associate Chairman, VTSS, Stanford University, *"VTSS at Stanford University: Experiences and Prospects."*
Leon Trilling, Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology, *"Teaching in the STS Mode: The MIT Experience."*

SUN 9:00-10:00 a.m. SALON E

STS: IONA COLLEGE

Panelists from a small college discuss what they have done to implement STS across the disciplines.
Warren Rosenberg, Associate Professor of Biology.
Nicolyn J. Ausiello, Director of Laboratory Operations.
Victor A. Stanionis, Curriculum Director, Scientific and Technological Literacy Program.
Ming Huang, Associate Professor.

SUN 10:15-11:15 a.m. LEE ROOM

COLLEGE AND UNIVERSITY STS PROGRAMS AND COURSES CONFERENCE TABLE

James R. Phillips, Babson
Earl Hansen, Lewis and Clark
Barbara Ann Radtke, Emmanuel College
Martin Sage, Syracuse

SAT 11:15 a.m. SALON VI

LARGE ENROLLMENT T/S COURSES FOR NONTECHNICAL MAJORS

James Adams, Stanford University
T.T. Liao, SUNY-Stony Brook
Rustum Roy, Penn State University

Richard J. Barnet, historian, foreign policy analyst and social critic, is the author of numerous books including Roots of War, Global Reach, Intervention and Revolution, The Giants: Russia and America, and The Alliance: America, Europe, Japan — Makers of the Postwar World. Mr. Barnet is a founder of the Institute for Policy Studies, its co-director from 1963 to 1978, and is currently a Senior Fellow.

George Bugliarello, President of Polytechnic University since 1973, is an engineer-and educator with a broad background ranging from civil engineering to computer languages, bio-medical engineering and fluid mechanics. He is the editor of Technology and Society and current **NASTS** President.

Denis Hayes is Chairman and CEO of Earth Day 1990. In 1970, He was executive director of the first Earth Day, which with an estimated 25 million participants was the largest political demonstration in history. During the Carter Administration, he served as Director of the federal Solar Energy Research Institute. An attorney, Hayes is now on leave from his San Francisco law firm.

Sandra Postel is the Vice President of the World Watch Institute and author of numerous articles on the environment.

Robert Rodale is Chairman of the Board and CEO of Rodale Press in Emmaus, Pennsylvania. Throughout his career, he has worked to develop, promote and gain acceptance for important and innovative ideas in the area of gardening, food and nutrition, and health and fitness.

Jeremy Rifkin, author of Entropy, Time Wars, and Algeny, is among the best known of the public interest advocates and activists. He is the founder of the Greenhouse Crisis Foundation.

F. James Rutherford, Chief Education Officer of the American Association for the Advancement of Science. He is currently the director of Project 2061, and a member of the National Council on Science and Technology Education, the Commission on Academic Freedom and Pre-College Education, and other national boards.

Claudine Schneider, a Republican Congresswomen from Rhode Island, was named one of five "Winners in Congress" by the Wall Street Journal. In her first term she led the fight against the Clinch River Breeder Reactor. Since then she has been at the forefront of national efforts to encourage policies that make efficient use of federal programs and spur economic growth while maintaining environmental quality.

John Shelby Spong, scholar, author and bishop, is the most published member of the House of Bishops of the Episcopal Church in the United States. He is the author of eleven books and has published over fifty articles.

PRE-CONFERENCE WORKSHOPS

7:30 - 9:00 PM THURSDAY, FEB. 1

PW-1 SALON A

WHAT CAN I DO ON MONDAY?

A hands-on workshop for first-time participants at TLC to aid them in taking something home from TLC.

Toni L. Miller, Biology Teacher, Ohio STS Network.

PW-2 SALON B

INTRO TO COLLEGE AND UNIVERSITY STS

What is happening at colleges and universities? What are people doing and Who is doing it? This is an overview of college and university STS activity.

Leonard Waks, STS Program, Penn State

PW-3 SALON H

MODERATOR TRAINING WORKSHOP

This is a workshop for all conference moderators. It will deal with creating a more informal environment for the presentations to help foster discussion and interaction with all participants.

Janice Koch, Hofstra College.
Connie Barlow, Science Writer.
Dorothy Rosenthal, California State University, Long Beach.
Carolyn Graham, NASTS Vice President.

Will be repeated 8:00 AM Friday

UNDERSTANDING THE PROGRAM

All Workshops and Sessions will have the following indentification bar with inverse printing. The coding of the bar is as follows:

TYPE ROOM CODE

TYPE = type of session

PW = Pre-Conference Workshop
WS = Workshop
CS = Concurrent Paper
CT = Conference Table
RT = Round Table
EB = Early Bird

ROOM

gives the Salon or Room for the session.

PROGRAM CODING

SNS	Science for the Non-Scientist Symposium.
NUKE	Nuclear Power Revisited Symposium.
EDUC	Education related sessions.
#-# ED	Education sessions for specific grades.
COLL ED	Education sessions for college level.
ENVIR ED	Environmental Education sessions.
ENVIR	Environmental Theme related sessions.
BIO-MED	Health Theme related sessions.
WORK	Technology and Work Theme sessions.
PERSP	Perspectives Theme related sessions.
INFORM	Information Theme related sessions.

DEVEL	Sessions dealing with Development Issues.
ENGLISH	Sessions of special interest about English.
INFML ED	Sessions for Informal Education Sector.
INTER	Sessions for International Sector.
MINORITY	Sessions dealing with Minority Issues.
NETWK	Networking sessions.
TECH LIT	Sessions concerning Technological Literacy.
WOMEN	Sessions dealing with Women's Issues.

8:30 AM

OPENING PLENARY

SALON IV

TECHNOLOGICAL LITERACY CONFERENCE-V

WELCOME: **Carolyn Graham**, NASTS Vice President and Conference Chair.
George Bugliarello, NASTS President.

Theme 1

EMPOWERING CITIZENS IN A TECHNOLOGICAL WORLD

Education is one of society's most cost-effective technologies for empowering people to act. A little bit of knowledge can go a long way in the right hands.

KEYNOTE SPEAKER:	**GEORGE BUGLIARELLO**, President, Polytechnic University and President, NASTS.
RESPONDERS:	**Morris Shamos**, author on Science Literacy **Allan McClelland**, National Science Foundation

10:00 - 11:00 AM: **BREAKOUT SESSIONS**

Follow-up discussions of Opening Plenary presentation within each sector.
Please go to the session that best fits you.

SALON A
Elementary School

SALON B
Middle School

SALON C
High School Science
Irma Jarcho and John Harkness, MODERATORS

SALON E
High School Humanities

SALON F
High School Technology Ed

SALON H
College and University STS
Stephen Cutcliffe, MODERATOR

SALON J
College and University Science Ed
Robert Yager, MODERATOR

SALON K
College and University General Ed
Carl Wood, MODERATOR

MADISON ROOM
Students
Student Pugwash USA will MODERATE

LEE ROOM
Scientists and Engineers

JEFFERSON ROOM
Religion Professionals
James Salmon, MODERATOR

JACKSON ROOM
Museums and Science Centers

11:15 AM-12:15
PLENARY TWO

SALON IV

THEME IV

PARALLEL APPROACHES TO HEALTH

Many "systems" of healing are emerging in parallel with or as genuine alternatives to traditional high-tech medicine. Participants will be exposed to the latest developments in each of several fields from Relaxation-Response to Acupuncture.

KEYNOTE SPEAKER:	**CONGRESSWOMAN CLAUDINE SCHNEIDER**, Republican from Rhode Island.
RESPONDER:	**Robert Rodale**, Chairman, Rodale Press, Inc.

11:00 AM - 2:30 PM
INFORMATION MARKET PLACE

Public Interest Organizations (SALON III) will have tables to display materials and show audio-visual presentations of their work. Representatives will be available to answer questions.

Socially Conscious Corporations (SALON I) will have tables to display reports, materials and audio-visual presentations dealing with their community and educational involvement. Representatives will be present to discuss their activities.

Exhibitors (The Foyers). Take this time to browse through the extensive displays of the conference exhibitors.

1:30 - 2:15 PM

INTRODUCTIONS TO MAJOR SYMPOSIA

INTRO-1 SALON V SNS

SCIENCE FOR THE NON-SCIENTIST

A symposium on teaching science to the 95% of the population that will not end up using it in the work place.

John Truxal, SUNY, Stony Brook.

See session listed on page P-5 for symposium program.

INTRO-2 SALON VI NUKE

NUCLEAR POWER REVISITED

A symposium examining the future of the nuclear industry and what role it might play in light of greenhouse fears and Chernobyl.

John Ahearne, Executive Director,Sigma Xi.

See sessions CSI.18, CSII.6, Guest Lecture I, and CS III.7

CONCURRENT PAPER AND WORKSHOP SESSION - ONE

2:30-3:30 PM FRIDAY, FEB 2.

WS I.1 SALON A K-6 ED

TECHNOLOGY PROCESS SKILLS FOR THE ELEMENTARY GRADES

This workshop will introduce technology process skills that complement the science process skills and that promote creativity and problem solving.

Donald R. Daugs, Professor of Elementary Education, Utah State University.

WS I.2 SALON B 5-8 ED

USING LOCAL AND GLOBAL PROBLEMS TO TEACH INTEGRATED SCIENCE

How to make your science classes more interesting and relevant by using everyday local and global problems as starting points for demonstrations, investigations and discussions.

Mike Robinson, Department of Curriculum and Instruction, University of Nevada, Reno.

WS I.3 SALON C 9-12 ED

REAL-WORLD PROBLEM SOLVING: A CLASSROOM STRATEGY

Participants in this workshop will practice using an STS problem-solving strategy called technology assessment to examine a socially-related science issue. All participants will leave the session with enthusiasm and expertise to incorporate TA into their school curriculum.

David C. Tucker, Physics/Chemistry Teacher, Mount Baker High School.
Donald Shepherd, Biology Teacher, Mount Baker High School.
Louise Baxter, Biology Teacher, Sumner High School.
Robert Yager, University of Iowa, MODERATOR.

WS I.4 SALON E COLL ED

IMPLEMENTING THE STS APPROACH ACROSS THE COLLEGE CURRICULUM

Participants will be presented with several specific curriculum items from both technical and liberal arts subjects and be challenged to explore how they would apply an STS approach.

Gary Beneson, Department of Technology, City College of New York.

WS I.5 SALON J ENVIR

GLOBAL WARMING AND THE GREENHOUSE EFFECT: AN ACTIVITY-BASED STS UNIT FOR HIGH SCHOOL STUDENTS

The Workshop will involve the review of an activity-based unit on the cause and effect of the global warming trend, with audience participation in selected activities. Copies of the material will be distributed to those in attendence.

Dorothy B. Rosenthal, Lecturer, Science Education, California State University, Long Beach.

CS I.6 SALON K SNS

ENGINEERS AND TECHNOLOGICAL LITERACY

This panel will discuss what the engineering profession and engineering education can and should be doing to promote technological literacy in our society through intervention in various educational processes at the university level.

David Reye-Guerra, Executive Director of the Accreditation Board for Engineering and Technology.
Wilbur L. Meier, Director, Office of Engineering Infrastructure Development, National Science Foundation.
Curtis J. Tompkins, Dean, College of Engineering, West Virginia University; President-elect, American Society for Engineering Education.
Russel C. Jones, University Research Professor, University of Delaware; Past-President, ABET, MODERATOR.

CS I.7 SALON H MINORITY

MINORITY PERSPECTIVES ON ETHICS AND VALUES STUDIES IN SCIENCE AND TECHNOLOGY

Discussion of minority perspectives on ethics and values issues in science and technology, and the implications minority values perspectives may have for science and technology education, policy, and research.

Amy Crumpton, Program Assistant, Professional Ethics Program, Directorate for Science and Policy Programs, AAAS, MODERATOR.
Taft Broome, Jr., Chairman, Howard University Senate.
J.V.Martinez, Atomic Physics Program Manager, U.S. Department of Energy.
Robert F. Murray, Jr., Chief, Division of Medical Genetics, Howard University.

CS I.8 JACKSON ROOM EDUC

INCORPORATING HISTORY INTO STS EDUCATION

Three papers on the rationale and use of history in teaching science, social studies and STS. Practical issues and examples will be used.

Rodger W. Bybee, Associate Director, Biological Sciences Curriculum Study, and **James R. Giese**, Executive Director, the Social Science Consortium, Boulder Colorado, *"Integrating the History and Nature of Science in School Science and Social Studies Programs."*
Dennis W. Cheek, Coordinator of Curriculum Development, NYSTEP, *"Incorporating Historical Perspectives into STS Curriculum Materials: Some Practical Examples."*
Stephen G. Brush, Professor of History and Institute for Physical Science and Technology, University of Maryland, *"History of Science and Science Education."*

CONCURRENT PAPER AND WORKSHOP SESSION - ONE

2:30-3:30 PM **FRIDAY, FEB 2.**

CS I.9 JEFFERSON ROOM INFORM

INFORMATION OVERLOAD, TECHNOLOGICAL LITERACY AND THE CLASSROOM

This collection of papers starts with the overwhelming nature of current information technology and its implication for Democracy and then explores how information technology can be used to support Technological Literacy in the classroom.

Eduardo Alberto Castro, INIFTA,- Division Quimica Teorica, Argentina, *"Are We Condemned to be Crushed by the Information Overload."*
Nancy McIntyre, Project Administrator, School of Education, West Chester University, *"From Slates to Satellites for Students."*
Allen B. Johnson, Associate Professor of Science, The General College - University of Minnesota, *"The Enhancement of Science Teaching with Resources from the Popular Media."*

CS I.10 MADISON ROOM INFML ED

INFORMAL EDUCATION ONE: MUSEUMS

This Session reviews the role that Museums and Botanical Gardens are playing in promoting Technological Literacy.

John R. Hensley, Gallery Development Director, St. Louis Science Center, *"Neutrality, Advocacy or What? Science, Ethics and the Public in Science Centers."*

A Representative from the Smithsonian Institue will speak on their student outreach program.

WS I.11 LEE ROOM TECH LIT

TECHNOLOGICAL LITERACY AND DEMOCRATIC PARTICIPATION

The session leaders will present for discussion a proposed curriculum for training citizens to participate more fully in a democratic society by teaching them technological literacy, research skills and policy analysis skills.

Mary Ann Young, Research Analyst, Office of Technology Assessment.
Thomas M. Grundner, Director, Community Computing Laboratory, Case Western University.

CS I.12 SALON G NETWK

NATIONAL STS NETWORK: ITS IMPACT

Presenters will examine the impact of the National STS Network on STS Education in the nation.

Barbara Barchi, Director, National STS Network.

Others to be announced.

CS I.13 SALON VI ENVIR

EDUCATING YOUNG PEOPLE FOR A SUSTAINABLE ENVIRONMENT

Presenters will talk on new initiatives in education sponsored by Legacy International.

J.E. Rash, President, Legacy International.
Ira Kaufman, Executive Director, Legacy International.

CS I.14 SALON F ENGLISH

POETS RESPOND TO TECHNOLOGY

Explore how poets have dealt with technology's impact on every area of life.

William Studabaker, College of Southern Idaho, *"Technology and Poetry: David Wagner and Perfecting the Wingless Metaphor,"* MODERATOR.
David Foltz, Indiana University of Pennsylvania, *"Vincent Huidobro's Altazor: A Poetic Ascent into Cosmic Space."*
Carl Wood, Principia College, *"An African Poet's Lament on Technological Disruption: p'Bitek's Song Lawino."*

CS I.15 ALEXANDRIA ROOM BIO-MED

ALTERNATIVE HEALTH APPROACHES PANEL

Panelist will represent alternative health approaches and will discuss the merits of their approach.

Robert Walker, The Pennsylvania State University, MODERATOR.
Dr. Nicholas Placenta, MD, Maharishi Ayurveda Medical Center, Washington, D.C.

CS I.16 SALON IV COLL ED

DIALOGUE: "SCIENCE" LITERACY AS A GOAL

Morris Shamos and Audrey Champagne will respond to the question: Is "Scientific Literacy" possible?

Morris Shamos, noted author on Science Literacy and former NSTA President.
Audrey Champagne, Senior Program Director, AAAS.
Glen Aikenhead, NASTS Board, MODERATOR.

CS I.17 SALON V NUKE

NUCLEAR POWER REVISITED PANEL

Panelists will examine the future of the nuclear industry in light of the changed environmental situation.

Bill Williams, Penn State University.
Les Ramsey, Science Concepts, Inc. Washington, DC.
Carl F. Patrick, Director of Nuclear Policy and Information, New York Power Authority.
Robert M. Jefferson, nuclear spent fuel consultant.
Michael Mariotte, Executive Director, Nuclear Information and Resource Service.

CONCURRENT PAPER AND WORKSHOP SESSION - TWO

3:45-4:45 PM FRIDAY, FEB 2.

CS II.1 SALON A K-6 ED

THREE MODELS FOR DEVELOPING STS PROGRAMS IN ELEMENTARY SCHOOLS

Three Models for developing STS programs in elementary schools will be shared along with materials and procedures used with students.

Janet Dunkel, Teacher, Jefferson Elementary School.
Veda Flint, Teacher, Northeast Elementary School.
Joan McShane, Teacher, Jefferson Elementary School.
Robert E. Yager, Professor of Science Education, University of Iowa, MODERATOR.

CS II.2 SALON B EDUC

THE CENTER FOR YOUTH IN ENGINEERING AND SCIENCE: A MODEL FOR UNIVERSITY - HIGH SCHOOL COLLABORATION

Panelists will emphasize the university-school collaboration through an examination of the various pre-college programs and the success and failures in the development and implementation of these programs. Program literature will be available to participants.

James T. Conti, Vice President for Educational Development, Director, Center for Youth in Engineering and Science.
Sean C. McRae, Program Director, Center for Youth in Engineering and Science.
Elizabeth A. Sciabarra, Director, Academic Collaborative Projects, Polytechnic University, MODERATOR.

WS II.3 SALON C WORK

THE EUROPEAN COMMUNITY: A CLASSROOM SIMULATION

After a brief description of the ways the European Community is structured and functions, current and future science and technology cooperation, participants will simulate a meeting of the European Council of Ministers.

Sara F. Anderson, Instructor of Social Science, Northern Virginia Community College.

CS II.4 SALON E COLL ED

INFILTRATING HISTORY INTO GENERAL EDUCATION

Lectures, courses, and course sequences are current mechanisms to infiltrate the history of technology into general education. Panelists discuss examples and resources. Handouts.

J. Paul Hartman, University of Central Florida, *"Infiltration Techniques and Technologies.,"* MODERATOR.
Stephen H. Cutcliffe, Lehigh University, *"Technology Studies Resources in the History of Technology."*
Guy Beckwith, Auburn University, *"Technology and Civilization: The Auburn Experience."*

CS II.5 SALON J ENVIR

GIRDING FOR THE GREENHOUSE

Results of a multinational study of the measures needed to control emissions leading to acid rain and the greenhouse effect over the next half century.

Douglas Hill, Project Head, IEA Energy Technology Systems Analysis, Brookhaven National Laboratory.
Howard Reiquam, Director of Environment and Safety, Gas Research Institute.
Barry Solomon, Climate Change Division, U.S. EPA.
Ted Williams, Director of Environmental Analysis, U.S. Department of Energy.

CS II.6 SALON K NUKE

THE OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

Panel will discuss various programs, giving special attention to educational outreach.

Donald H. Williams, Professor of Chemistry, MODERATOR.
Antionette Joseph, Director of Field Operations Management, Office of Energy Research.
Ginger King, Director of Information Services for OCRWM.

CS II.7 SALON H WORK

CELEBRATING THE BICENTENNIAL OF U.S. PATENT AND COPYRIGHTS WITH A LOOK AT INVENTORS AND INVENTING

This Panel will examine the history of invention in America and the role of the Patent and Trademark Office and will highlight the contribution of Women Inventors. This Panel is sponsored by the bicentennial of the U.S. Patent and Copyrights Office.

Fred M. Amram, Professor, General College, University of Minnesota, *"Technology and Values Visit the Patent and Trademark Office Bicentennial."*
Rachelle Sender Beauchamp, Co-Director, Women Inventors Project, *"Circuit Boards on the Breakfast Table."*
Karen Kozlara, Professor, School of Business and Management, Temple University, *"Invention and Innovation: Some Unanswered Questions."*

CS II.8 SALON F ENGLISH

LATIN AMERICAN POETS RESPOND TO TECHNOLOGY

Presenters will share the unique responses of the Latin American Poets to the problems brought by modern technologies.

Jane Robinette, Polytechnic University.

CS II.9 JEFFERSON ROOM DEVEL

WHEN IS TECHNOLOGY TRANSFER APPROPRIATE? CASE STUDIES IN EGYPT, INDIA AND BANGLADESH

This workshop will examine when and why technology transfer is appropriate and when it is inappropriate. It will also examine criteria for the planning, implementation, and evaluation of technology transfer projects.

Bernard denOuden, Chairman, Department of Philosophy, University of Hartford.

CONCURRENT PAPER AND WORKSHOP SESSION - TWO

3:45-4:45 PM **FRIDAY, FEB 2.**

CS II.10 SALON G MINORITY

ENGLISH AS A SECOND LANGUAGE

Presenters will look at issues concerning the education of individuals whose primary langauge is not English.

Sheryl Santos, Associate Professor of Multicultural Education, Arizona State University. *"Meeting the Challenge of STS Education for Language Minority Population in the U.S.A."*
Judith W. Rosenthal, Professor, Biological Sciences, Kean College of New Jersey, *"Keeping the Hispanic Student in College and in the Sciences - Creative Solutions at Kean College of New Jersey."*
Faith A. Foltz, Master Teacher, PA Migrant Education Program.

CS II.11 JACKSON ROOM PERSP

MYTHS WITHIN OUR SCIENTIFIC AND TECHNOLOGICAL SOCIETY

Presenters will look at various myths that exist in our scientific and technological society and examine their impact on the present as well as the future.

Douglas D. Noble, Spencer Fellow, University of Rochester, *"The Myth of High Tech Skills."*
Carlos Verdugo, Institute of Humanities, University of Valparaiso, Chile, *"Technology as Power in the Third World."*
Rustum Roy, Penn State University, *"S & T Images from US and Soviet cartoonists via V.V.Nalimov."*

CS II.12 LEE ROOM TECH LIT

DEALING WITH TECHNOLOGICAL LITERACY

Presenters will explore issues concerning Technological Literacy and dealing with non-engineering and science majors in the science and technology classroom.

Carl S. Frankel, Assistant Professor of Biology, Penn State University, *"Teaching Science to the Unimpressed."*
David L. Adams, Director of Natural Sciences, Babson College, *"Nonscientists Deserve 'Real Stuff' in their Science Courses."*
Art Rosser, Dean, College of Applied Sciences and Technology, Central Missouri State University, *"Assessing Technological Literacy."*

CS II.13 MADISON ROOM INFML ED

THE WORCESTER POLYTECHNIC INSTITUTE SCHOOL/COLLEGE COLLABORATIVE IN MATH AND SCIENCE EDUCATION

An open-ended workshop addressing the various components and strategies that are essential in establishing and maintaining effective school/college collaboratives.

Frank Trainor, Director of the WPI School Collaborative, Worcester Polytechnic Institute.
Lance Schachterle, Interdisciplinary Studies Division, Worcester Polytechnic Institute.
Tamara Payne Collier, Management and Training Consultant.
Michael Silver, Science Facilitator for the Worcester Public Schools.

CS II.14 SALON II EDUC

PROJECT 2061 OPEN FORUM

Panelists will present a short critique of Project 2061 and participants will have an opportunity to discuss implications and directions. James Rutherford, AAAS will give closing comments. See Project 2061 Summary in conference edition of **Bulletin of STS**.

James Johnson, NASTS board, MODERATOR
Dorothy Rosenthal, Lecturer, California State University.
Paul Jablon, Middle College High School.
James Rutherford, Director Project 2061, AAAS, Closing Commentor.
Others to be announced

CT II.15 SALON I K-12 ED

IMPLEMENTING K-12 STS EDUCATION

Presenters will discuss methods for implementing STS into the Classroom.

Willis J. Horak, Associate Professor of Teacher Education, University of Arizona, *"Integrated STS Lessons in an Elementary Science Methods Course."*
Thomas B. Ervin, Earth Science Teacher, Davenport Iowa, *"A Compromise Between Reality and Pure STS."*
Robert D. Weber, Professor of Technology Education, Trenton State College, *"New Jersey's K-12 Technology Education Curriculum."*
Thomas B. McKeeman, Wissahickon School District, Pennsylvania, *"STS Instruction: Crossroads or Four-Lane Highway?"*

WS II.16 SALON VI ENVIR ED

SOLAR ENERGY: PHOTOVOLTAICS IN THE CLASSROOM

Introduction to Photovoltaics. An educational program for high school science teachers from Maryland/Virginia/D.C. Hand-out materials.

Paul Maycock, PV Energy Systems.
Ken Sheinkopf, Solar Energy Industries Association.

CS II.17 SALON V COLL ED

NURTURING NOT WEEDING: A NEW LOOK AT THE UNDERGRADUATE EXPERIENCE

Panelists from Sigma Xi will examine the effects that entry-level courses for undergraduates, science and non-science majors, have had on students' interest in science and technology and that the over-emphasis on research has had on teaching.

M. Patricia Morse, Professor of Biology, Marine Science Center, Northeastern University, and President, Sigma Xi, MODERATOR.
Anna J. Harrison, Professor Emeritus, Department of Chemistry, Mount Holyoke College.
John Ahearne, Executive Director, Sigma Xi.
Shirley M. Malcolm, Head, Directorate for Education and Human Resources Program, AAAS.

5:00-6:00 PM
Guest Lectures 1

SALON I

"A Science Curriculum Empowering Citizens for Life, Living, Learning and Working in a Technological World."

Paul Hurd, Science Education Researcher, Professor Emeritus, Stanford University.

One of the premier science education researchers will talk about the current state of Science Education.

SALON H

"The Nuclear Guardianship Project"

Ed Fuller, and **Wendy Oser**, The Fire Group, Berkeley, CA.

This lecture is part of our symposium on the Nuclear Industry. It will deal with an idea for monitoring nuclear waste by building scientific communities over the storage sites.

SALON V

"Too Many or Too Few Scientists and Engineers?"

Daryl Chubin, Office of Technology Assessment.

We are constantly told that there are not enough scientists and engineers in the U.S. Find out the surprising conclusions from OTA's recent study .

SALON VI

"Prevention as the Key Alternative Health Approach"

Robert Rodale, Chair, Rodale Press, Inc.

The follow-up lecture for the Health and Bio-Medicine Theme will be about the use of preventive medicine.

SALON II

"Gender, Genesis and Generosity: The Early Impact of Women on Science and Technology."

Mary Hunt, Women's Alliance for Theology, Ethics and Ritual.

The Role of Women in the Science and Technology paradigm is likely to change drastically in the near future.

Next Year's TLC will stress the theme "Women, Technology and Science" with an emphasis on women's concerns.
Dr. Hunt's talk will be an excellent introduction

7:30 - 8:30 PM

PLENARY THREE **SALON III**

Theme V

COSMOS, CREATION AND CONSCIOUSNESS

Science and technology continue to expand human knowledge of the universe from Voyager's view of Neptune to the CERN accelerator's penetration deep into the atom's nucleus. Contemporary Theology articulates these insights into its cosmology.

KEYNOTE SPEAKER: **THE RIGHT REV. JOHN SPONG**, Bishop of the Episcopal Diocese of Newark, NJ.

"THE IMPACT ON THEOLOGY OF THE SCIENTIFIC REVOLUTION"

RESPONDER: **James Salmon**, Maryland Province of the Society of Jesus.

ANNUAL MEETING OF NASTS MEMBERS

All conference attendees who have paid their registration fee are automatically members of NASTS and are invited to attend the Members Meeting.

Day: Friday, February 2, 1990 Time: 8:30 PM Location: Salon III

AGENDA

1. Welcome by Chair: George Bugliarello, NASTS President, "State of STS in Nation and World."
2. Report by the Corporation Chair, Rustum Roy.
3. Election Results for Board Members and Vice-President.
4. Proposed change in Article 5(3) of the Constitution.
5. Discussion of TLC-6
    a. overarching theme, e.g., "Women in Science and Technology"
    b. suggestions for main speakers, topics, workshops
    c. location
    d. local site visits:
        (1) Thomas Jefferson High School (magnet school); Smithsonian Environmental Research Center; Patent Office; Geological Survey; etc.
        (2) may require additional charges: admission fees, transportation
        (3) arrange for Thursday preceding TLC
    e. role of members in getting TLC symposia funded.
6. Open discussion on initiatives and projects members would like to undertake through the Association.
7. Suggestions for the good of NASTS.
8. Open Invitation to NASTS members to attend TLC-6 planning meeting 1:15 Sunday.

EARLY BIRD LECTURES

8:00 - 8:45 AM SATURDAY, FEB. 3, 1990

8:00 - 8:45 AM
EARLY BIRD LECTURES

EB I.1 SALON G

ISSUES INVOLVED IN DOING SCIENTIFIC RESEARCH IN THE CONTEXT OF A UNIVERSITY-UNION AGREEMENT

The University of Quebec has an agreement with 2 major trade unions providing that the unions may request the services of professors for educational research. This leads to an unusual context for scientifiic research which poses methodological and funding problems.

Karen Messing, University of Quebec.

EB I.2 SALON F

DEVELOPMENT OF TECHNOLOGY EDUCATION

A talk on what influences the field of Technology Education sponsored by a leader magazine in the field.

Scott Anderson, Editor-in-Chief, T.I.E.S. Magazine, Drexal University.

EB I.3 SALON E

THE ULTIMATE WEAPON IN AMERICAN CULTURE

By exploring the cultural history of America's superweapons, this talk offers a new perspective on the current debates over the nuclear arms race and SDI.

H. Bruce Franklin, Professor of English and American Studies, Rutgers University.

EB I.4 SALON H

TEACHING ABSTRACT SUBJECTS IN THE EARLY PRIMARY GRADES: CASE OF THE OXIDATION S-STS MODULE

Report on the design, implimentation and evaluation of an early elementary S-STS module.

Reginald Hopkins and **Linda C. Wiley**, students, Worcester Polytechnic Institute.

Brown bag lunches will be served over the noon hour for a reasonable price.

9:00 - 9:45 AM
PLENARY 4 **SALON III**

Theme III

EARTH DAY 1990: GLOBAL CLIMATE CHANGE

Of all the STS issues none will be more prominent in the immediate future than the whole complex set connected to the signs of a significant impact on the global climate.

KEYNOTE SPEAKER: **DENIS HAYES**, Chairman and CEO of Earth Day 1990 and Executive Director of the first Earth Day in 1970

"BUILDING A SUSTAINABLE FUTURE:
THE ROLE OF POLITICS, ECONOMICS AND CULTURE"

10:00 - 11:00 AM
Guest Lecture 2

SALON III

"The Greenhouse Crisis"
Jeremy Rifkin, The Greenhouse Crisis Foundation

Learn about the international effort to deal with the problem of global climate change. This is the follow-up lecture to Denis Hayes' Plenary talk.

SALON I

"COSMOS, CREATION and CONSCIOUSNESS"
Langdon Gilkey, Divinity School, Chicago University.

This year's featured guest lecture for the Moral and Ethical Perspectives Theme. The lecture will look at the interface of Science and Religion on our way of understanding reality.

SALON II

"Project 2061"
James Rutherford, AAAS.

Learn about Project 2061, the major science education reform initiative of the American Association for the Advancement of Science, from the person who is running it.

CONCURRENT PAPER AND WORKSHOP SESSION - THREE

11:15 AM - 12:15 **SATURDAY, FEB. 3**

CS III.1 SALON A EDUC

STS SCOPE AND SEQUENCE

Presenters will deal with issues of Scope, Sequence and Coordination of science education. Hands-on examples will be used.

James D. Lubbers, Assistant Professor of Science Education, East Carolina University, *"An STS Scope and Sequence Model for 7-12 Science."*
Jane Abbott, Past President, National Association of Biology Teachers, *"STS Education in the Context of Scope, Sequence and Coordination."*

CS III.2 SALON B K-12 ED

CRESTON BECOMES STS: A TEAM EFFORT

Creston has gone STS. Starting with one teacher it has blossomed into a district commitment. See how it was done! You could do it too!

Curt Jeffryes, Science Teacher, Burton R. Jones Middle School.
Keith Langoltz, Elementary Principal.
Gene Lust, Middle School Principal
Robert Yager, University of Iowa, MODERATOR.

CS III.3 SALON J 9-12 ED

WHY THE STS INSTRUCTIONAL METHOD MAY FAIL

This session will explore serious obstacles to the successful implementation of STS in the secondary science curriculum. Observations resulted from experience with several NSF workshops.

John Tonnis, Professor of Chemistry, University of Wisconsin-La Crosse.
Roland Roskos, Professor of Chemistry, University of Wisconsin-La Crosse.
John Whitsett, Science Department Chair, Central High School, La Crosse.
Jon Harkness, Wausau West High School, MODERATOR.

WS III.4 SALON C 9-12 ED

DISCUSSIONS IN ETHICS FOR SECONDARY STS

This workshop will introduce participants to two ethical discussion models. Participants will discuss ethical issues in Biology, Medicine, and Chemistry.

Edward Zielinski, Assistant Professor, Biology, Clarion University of PA.
David Wiley, Assistant Professor, University of Scranton.
Ron Truex, Science Teacher, Ocean Township High School.

WS III.5 JACKSON ROOM COLL ED

CANCELED

CS III.6 LEE ROOM COLL ED

PRINCIPLES OF CONTEMPORARY TECHNOLOGY

Taking the total contemporary technological enterprise as the universe of discourse, this paper presents a systematic array of principles underlying that enterprise.

Joseph F. Coates, President, J.F.Coates, Inc.
Vary T. Coates, Project Director, Office of Technological Assessment.

CS III.7 SALON K NUKE

PROBLEM PLANTS AND NUCLEAR LESSONS

This panel will examine a number of "problem plants," including among others the Washington Public Power Supply System, Shoreham, San Onofre, and the lessons to be learned from them.

Steve Hoffman, College of St. Thomas, MODERATOR.
John Byrne, University of Delaware.
Edward Cassedy, Polytechnic University.
Marjorie Harrison, City University of New York.
Michael Mariotte, Executive Director, Nuclear Information and Resource Service.
Kenneth Bossong, Critical Mass.

WS III.8 SALON H PERSP

SCIENCE AND NEW-AGE WAYS OF KNOWING IN THE STS CONTEXT

A comparison and contrast of ways of knowing and discussion on their integration into the STS context.

Gwen Blair Frazier, State Consultant, New Hampshire Division of Instructional Services.
Robert A. Walker, STS Program, Penn State University.

CONCURRENT PAPER AND WORKSHOP SESSION - THREE

11:15 AM - 12:15 **SATURDAY, FEB. 3**

CS III.9 SALON G EDUC

THE NATIONAL DIFFUSION NETWORK

An array of science and science-technology-society programs are available through the National Diffusion Network. Learn more about several of these programs from persons associated with the projects.

Mary Lewis Sivertsen, Education Specialist, National Diffusion Network, U.S. Department of Education, MODERATOR.
Donald C. Lisowy, Project WIZE, New York Zoological Society/Bronx Zoo Education Department.
Francis M. Pottenger, III, Curriculum Research & Development Group, University of Hawaii

CS III.10 MADISON ROOM EDUC

STS RESEARCH REPORT

Undergraduate Students will report on the various STS projects they have done. Come see what is being done in STS at the undergraduate level.

Reginald Hopkins and **Linda C. Willey**, students, Worcester Polytechnic Institute, *"Elementary STS Science Curriculum Evaluated."*
Sharon Katz, student , Princeton University, *"Renewable Energy in the News."*
Jimmy P. Chin, Andrew D. Galasso, and **Tuan A. Vo**, students, Worcester Polytechnic Institute, and **Dorothy Bagley**, Chemistry Teacher Shrewsbury High School,*"Student Response to S-STS Curriculum: A Study of* ***ChemCom."***
Abdullah Jabir and **Zainal Tukimin**, students, Worcester Polytechnic Institute, *"Computer Conferencing for NASTS."*

CS III.11 SALON E WOMEN

CANCELED

CS III.12 SALON F DEVEL

U.S. TECHNOLOGY AND THIRD WORLD DEVELOPMENT - SOCIOLOGICAL AND LITERACY VIEWPOINTS FOR EDUCATORS

An interdisciplinary survey for Teachers on problems with our technology overseas and how to solve them.

Wayne A. Bragg, Washington University - St. Louis, *"How Development Problems Arose: A Sociological-Historical Overview."*
Carl Wood, Principia College, *"Novelists, Playwrights and Poets on Technology and Development in Africa - Okot p'Bitek, Ngugi wa Thiong'o, Chinuna Achebe, and Wole Soyinka."*
Eugene B. Schultz, Jr., Washington Univeristy - St. Louis, *"Major Current Problems of Technology and Society in the Third World."*

CS.III.13 JEFFERSON ROOM COMP

STS NETWORKING THROUGH COMPUTER CONFERENCES

The session will explore the use of computer conferencing as a means to enable STS educators and others to work together while separated by time and distance.

Graham Orpwood, Program Director, Science Education, New York University, MODERATOR.
Lisa Carlson, President, Metasystems Design Group.
Nancy Stefanik, Network Manager, Advocacy Institute.

C III.14 SALON I EDUC

CONCRETIZING SCIENCE: MATERIALS SCIENCE AND TECHNOLOGY

Participants will learn about several national materials education projects; about activities to integrate concepts of materials science; and resources to assist them in their present efforts.

James A. Jacobs, Department of Technology, Norfolk State Univeristy.

WS III.15 SALON II ENVIR

OUTDOOR FIELD STUDIES: SEE YOUR STUDENTS IN A DIFFERENT LIGHT

This workshop will present the various ways in which educators can use outdoor settings to support their teaching of Natural Science.

Jeffrey De Pew, Coordinator/Instructor Henry Shaw Academy, Missouri Botanical Garden.

RT III.16 SALON V ENVIR

ENVIRONMENT AND TECHNOLOGY ROUNDTABLE

Panelists will begin a discussion on Environmental Philosophy.

Eric Higgs, University of Alberta.
Paul Durbin, University of Delaware.
Carl Mitcham, The Pennsylvania State University.
Langdon Winner, Rensselaer Polytechnic Institute.
Eric Katz, New Jersey Institute of Technology.
Robert Rodale, President, Rodale Press.

RT III.17 SALON III ENVIR ED

101 WAYS TO SAVE THE EARTH LESSONS

A multitude of classroom lesson plans will be displayed for the participants by their creators.

CS III.18 SALON VI SNS

LARGE ENROLLMENT T/S COURSES FOR NON-TECHNICAL MAJORS

Representatives from some of the oldest STS Programs in the nation will examine how they deal with large enrollment classes.

James Adams, Stanford University.
Rustum Roy, The Pennsylvania State University.
T. T. Liao, SUNY - Stony Brook.

TECH TUTORIALS

12:30 - 1:15 PM SATURDAY, FEB. 3

TT.1 SALON A

THE USE OF A DATA BASE IN NINTH GRADE EARTH SCIENCE

The use and logistics of using Accu-Weather's data base system in ninth grade Earth Science.

Alfred B. Capotosto, Ninth Grade Earth Science Teacher, Marple Newtown School District, Pennsylvania.

TT.2 SALON B

CONNECTIVITY, COMPUTERS, AND EDUCATION

Linking computers together by networking can increase the breadth, depth and efficiency of many educational projects. Includes Hands-on demonstration of DASnet autoporting.

Dwight Steward, Professor of English, and **Barbara Steward**, Professor of English, Delaware State College.

TT.3 SALON C

USING HYPERMEDIA IN THE STS CLASSROOM TO ENHANCE VISUAL LEARNING

IBM's hypermedia, LinkWay, provides the educational tool that merges teaching and technology into an efficient visual delivery system.

Henry D. Dobson, Assistant Professor, Bloomsburg University, and **Richard Kline**, Science Educator, Bloomsburg School District.

TT.4 SALON E

ISSUES OF WORKPLACE SMOKING

Research on the effects of smokers in the workplace, its impact on health and health care and the ethical implications will be given.

Lorrayne Y. Baird-Lange, English Department, Youngstown State University.

TT.5 SALON F

FLIP-FLOP YOUR WAY TO MEMORY

Do your students see the computer as a "black box?" Come trip down "Flip Flop" Lane as we build wonderful memories together. In this hands-on workshop you'll learn digital electronics needed to construct your own memory circuits.

Mark Curran, Teacher, **Lola Piper**, Teacher, and **Bob Gotwals**, Teacher, Montgomery Blair Magnet Program, Maryland.

TT.6 SALON G

IN SEARCH OF THE ENVIRONMENTALLY CONSCIOUS SCHOOL

Methods of reducing the environmental impact of school practices. Included are recycling, waste management, energy consumption, and generation of toxic substances in the school setting.

Michael Jabot, Teacher, Oneida Senior High School, New York.

TT.7 SALON H

ART AND THE SOCIAL IMPACT OF MODERN TECHNOLOGY

Nineteenth and twentieth-century art works help illuminate some of the central social issues posed by modern technologies.

Julie Wosk, Associate Professor,SUNY, Maritime College.

TT.8 MADISON ROOM

RURAL WASTE MANAGEMENT THROUGH RESOURCE CONSERVATION

A comparison of the threats from these two families of waste will be made, and a report on present state-of-the-art technology on managing such.

James Johnson, Executive scientist, (Retired), 3M Corp.

TT.9 SALON J

WHAT GOES AROUND...COMES AROUND

Activity filled experience where various methods for dealing with environmental problems will be demonstrated.

Shirlee S. Cavallere and **CHESAPEAKE BAY RESEARCH STUDENTS**, Gettysburg Senior High School.

TT.10 SALON K

FUELING OUR FUTURE: ENERGY POLICY AND THE ENVIRONMENT

Energy Policy is at the heart of strategies to cure the environmental ills brought about by humanity's development. This talk will examine the UCS report COOL ENERGY: The Renewable Solution to Global Warming.

Michael Brower, Energy Analyst, Union of Concerned Scientists.

TT. 11 SALON II

EXPERIENCES WITH THE NEW LIBERAL ARTS AND AG-LIBERAL ARTS

Representatives from NLA and Kellog projects will discuss their programs and their impact in education at the college-university level.

Richard Haynes, University of Florida, Kellog Grant Project.
Sam Goldberg, NLA, Sloan Foundation.

TT.12 SALON I WOMEN

WOMEN IN STS: [OUTSIDERS]^2 ?

This workshop is a working session designed to address the issues and concerns of women in STS education. An agenda for action to engage more women in STS will be developed.

Janice Koch, Assistant Professor, Education, Hofstra University.
Rachelle Beauchamp, Co-Director, Women Inventors Project.

1:30 - 3:45 WORKSHOP

WS-1 SALON B WOMEN

EDUCATING WOMEN FOR EMPOWERMENT IN A TECHNOLOGICAL WORLD

Panelists will discuss how science and technology education is, and is not, empowering women for full participation in a technological world.

Shelly Beauchamp, Inventor and Co-Director of The Women's Inventors Project.
Elaine Bernard, Executive Director, Trade Union Program, Harvard University.
Janice Koch, Assistant Professor of Elementary Science Education, Hofstra University.
Graham Orpwood, Director of Science Education, New York University.
Judith Weis, Professor of Biology, Rutgers University and Program Director, Undergraduate Division, National Science Foundation.

2:00 - 3:45 PM SALON III

THE NATURE OF STS

Paul Durbin, University of Delaware, MODERATOR.

Three leading university scholars present their current views on the interaction of Science and Technology with Society. Their papers are published in the special TLC edition of the **Bulletin of STS**.

Langdon Winner, Rensselaer Polytechnic Institute.
Susan Cozzens,Rensselaer Polytechnic Institute.
Melvin Kranzberg, Georgia Institute of Technology.

2:15 - 3:45 PM
WORKSHOPS

WS-2 SALON C EDUC

STS - THE NEXT GENERATION: RESTRUCTURING THE SCHOOL

This hands-on workshop will include simulations and roleplaying, participant collaborative group experimenting and designing of site-specific activities and strategies.

Paul Jablon and **Terry Born**, Co-Directors, The BONGO Program.

WS-3 SALON A ENGLISH

LANGUAGE: BOUND AND FREE IN SCIENCE AND TECHNOLOGY

English language paradoxes—restricting thinking yet encouraging creativity—are explored by panelists in science, English and multicultural classrooms from STS perspectives.

Edward R. Fagan, Professor Emeritus of Education and STS, Penn State University, MODERATOR.
Carlotta Dwyer, Head English Department, Thomas Clark High School, San Antonio, TX.
Matthew R. Nikkari, Coordinator/Liaison English/Science Writing Course, Wayne State University.
Andrew Jackson, Undergraduate Counselor, Penn State University.

4:00 - 5:00 PM
PLENARY FIVE SALON III

Theme II

TECHNOLOGY FOR THE GLOBALIZED ECONOMY

Business Week in its innovation issue raised the specter that advances in technology are now disadvantages to the U.S. position in a global economy. After introductory talks on the decline of U.S. technology and its role in the world, leaders from labor and the most advanced Japanese-American collaborations in manufacturing will discuss how it may be by innovation in the *Human Factors* that our industry will recover.

SPEAKERS: **Richard Barnet**, author of "Global Reach":
"The March of Globalization"
Rustum Roy, Evan Pugh Professor of the Solid State, Penn State.
"How the U.S. Lost the World Technology Cup"

CONCURRENT PAPER AND WORKSHOP SESSION - FOUR

5:15 - 6:15 PM **SATURDAY, FEB. 3**

CS IV.00 SALON II WORK

THE CHANGING NATURE OF THE AMERICAN WORKPLACE

The de-industrialization of America, the rise of the science sector, the lack of S/T trained minorities, and the loss of global competitiveness call out for radically new approaches in manufacturing. This session deals with some "new" thinking in this area.

Lauren Oliver, Manager of Training and Development, NUMMI.
Len Krimerman, Editor, Work Week.
Robert Hutchins, Executive Director, Opportunity Academy Management Training, MODERATOR
Trent Schroyer, T.O.E.S., The Other Economic Summit.

CT IV.1 SALON B K-12 ED

STS K-12 EDUCATION INSERVICE CONFERENCE TABLE

Presenters will share ideas on teacher inservice programs and hold an open discussion for the participants.

Roland Roskos and **John Tonnis**, Professors of Chemistry, University of Wisconsin-La Crosse, and **John Whitsett**, Science Department Chair, Central High School, La Crosse, *"An NSF Funded Workshop: STS Topics for Science Teachers."*
Dianne Q. Robinson, Director Interdisciplinary Science Center, Hampton College, *"A State-Wide STS Focused Science Enrichment Program for Elementary and Middle School Teachers."*
Janie Enter, Science Teacher, Jackson County Comprehensive High School, Jefferson, Georgia, *Inexpensive methods of Pre-Service and In-Service Training of STS Teachers."*
Constance H. Gordon, Associate Professor, Trinity College, *"Training Teachers to Develop STS Curriculum: Case Study in a Major School System."*
Jack Rhoton, Assistant Professor of Science Education, East Tennessee University, *"Program for the enrichment of Science/Technology/Society Education in the Elementary and Secondary Science Curriculum"*
Lloyd H. Barrow, Professor of Science Education, University of Missouri-Columbia, *"Energy Education Inservice for the 1990's."*
Robert E. Horvat, Chair, Department of Earth Science and Science Education, Buffalo State College, *"An Energy/STS Summer Institute for Teachers."*

WS IV.2 SALON C K-12 ED

NSTA'S SCOPE, SEQUENCE AND COORDINATION PROJECT AND THE STS CONTEXT

Learn how STS Concepts will affect NSTA's Scope, Sequence and Coordination Project and some sites that are proposing to use an STS approach.

Bonnie Brunkhorst, President-Elect NSTA, Professor, Science Education and Geology, California State University- San Bernadino.
LeMoine Motz, Past President NSTA.
Herbert Brunkhorst, California State University.
Robert Yager, Professor of Science Education, University of Iowa.

CS IV.3 SALON F ENVIR

SUSTAINABLE LIVING: WHAT CAN WE DO TO LIVE THE GOOD LIFE?

Participate in a discussion of what we can do to live a more sustainable life. Ideas will be discussed that can be used by anyone interested in sustainable living techniques. Actions will be emphasized.

Eco-Action Members, graduate and undergraduate students, Eco-Action of Penn State University.

CS IV.4 SALON E COLL ED

THE STS EXPERIENCE: MIT AND STANFORD

Learn what is happening in STS at two major communities.

William D. Rifkin, Graduate Fellow, and **Robert E. McGinn**, Associate Chairman, VTSS, Stanford University, *"VTSS at Stanford University: Experiences and Prospects."*
Leon Trilling, Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology, *"Teaching in the STS Mode: The MIT Experience."*

WS IV.5 SALON J 9-12 ED

INTEGRATE ENVIRONMENTAL ISSUES AND MOTIVATE STUDENTS!

This action-oriented workshop will demonstrate how to effectively integrate environmental issues into the existing curriculum and motivate students of all ages. Return home with a wealth of ideas and materials.

Shirlee S. Cavaliere and **Chesapeake Bay Research Students**, Gettysburg High School*.

*Recently featured in the WQED-TV series Conserving America, Challenge on the Coast.

CS IV.6 SALON I BIO-MED

THE INTERFACE OF MEDICINE AND TECHNOLOGY: RESUSCITATION A CASE IN POINT

The presentation will comment on the history of cardiopulmonary resuscitation and the issues of the medical advisability, resource availability, psychological stability, and ethical appropriateness for this intervention.

Daniel O'Hare, Fellow-in-Ethics, Memorial Sloan Kettering Cancer Center in New York City.

CONCURRENT PAPER AND WORKSHOP SESSION - FOUR

5:15 - 6:15 PM SATURDAY, FEB. 3

CS IV.7 SALON K EDUC

CORPORATE-BUSINESS PARTNERSHIPS FOR IMPROVING SCIENCE EDUCATION

Collaborative efforts to improve science education tapping the human and financial resources of corporations are emerging across America. Presenters will describe their coalition's involvement and detail methods and strategy for effective partnerships.

Chad Tolman, Research Leader, E.I.DuPont De Nemours & Co.
Stephen Cox, Project Coordinator, PRISM, Philadelphia.
James Sprague, New York State Electric and Gas Corp.
Dennis W. Cheek, Coordinator of Curriculum Development, NY STS Ed Project, MODERATOR.

WS IV.8 SALON H EDUC

GIRLS IN MATHEMATICS AND SCIENCE: AN ENDANGERED SPECIES?

This presentation addresses lack of and crucial need for female presence in mathematics, science, and technology. "Brainstorming" session crystallizes possible, viable research activities to find remedies.

Regina Baron Brunner, Assistant Professor of Mathematics and Computer Science, Cedar Crest College.

CS IV.9 SALON G INTER.

ESTABLISHING AN STS IDENTITY IN CANADA

This session will focus on promoting issues in STS curriculum area of study in Canadian Universities. Panelists will give a brief report from their established programs in Canada, followed by open discussion with the entire group.

Gerard F. McLean, Professor, Mechanical Engineering, University of Victoria, MODERATOR.
E. Higgs, Professor, STS Program, University of Alberta.
D. Huron, Professor, Centre for Society, Technology and Values, University of Waterloo.
W.Vanderberg, Professor, Industrial Engineering, University of Toronto.
G Aikenhead, Professor, Education, University of Saskatchewan.
R. Hudspith, Department of Mechanical Engineering, McMaster University.

CS IV.10 LEE ROOM WORK

THREE PERSPECTIVES ON MANAGEMENT OF SCIENCE AND TECHNOLOGY

The presenters will explore various ways Science and Technology are and could be managed in both the private sector and the government sectors.

Jerry Streichler, Dean, College of Technology, Bowling Green State University, *"Strategic Management of Technology: How industry does it - With Implications for Educators."*
Philip Kraft, Associate Professor of Sociology, SUNY-Binghamton, **Jorgen Bansler**, Assistant Professor of Computer Science, University of Copenhagen, *"The "Collective Resources Approach" to High Tech Work: Can the "Scandinavian Model" Work in the United States?"*
Larry D. Spence, Associate Professor of Political Science, Penn State University, *"Escaping the Boondoggle: Toward an Alternative Science/Technology Policy."*

WS IV.11 JACKSON ROOM EDUC

CREATIVITY: AMERICA'S UNLIMITED RESOURCE

The Patent Office Bicentennial provides an opportunity to teach inventing attitudes and skills. Handouts and hands-on experience in teaching problem solving of real-world issues with enhanced immagination.

Sandra Brick Pangborn, Science Museum of Minnesota.
Fred M. Amram, University of Minnesota.

CS IV.12 JEFFERSON ROOM DEVEL

TECHNOLOGY TRANSFER, COMPUTERS AND RESOURCES: ISSUES IN DEVELOPMENT

Presenters will share insights on issues concerning technology transfer, the environment and development.

David Bellin, Assistant Professor, Pratt Institute, *"Technology Transfer and Developing Nations."*
Janet Bergschneider, Assistant Professor of Computer Science, Meredith College, *"Meeting the Special Needs of Microcomputer Users with Limited Resources."*
David E. LaHart, Principal Instructor, Florida Solar Energy Center, *"Our Common Future: A Report of the World Commission on Environment and Development."*

WS IV.13 SALON A EDUC

NUTRITION SCIENCE WORKSHOP

Participants will learn innovative teaching strategies based on nutrition science experiments developed by the Penn State Nutrition Center. This workshop's emphasis is a hands-on learning experience and discussion.

Sally R. Anger, Outreach Coordinator, Penn State Nutrition Center.

CS IV.14 MADISON ROOM EDUC

"THE WORLD OF CHEMISTRY" - EDUCATING CITIZENS IN A TECHNOLOGICAL WORLD

"The World of Chemistry" Telecourse, for which major funding was provided by the Annenberg/CPB Project, presents through television programs and written materials a modern world in which society and technology are interdependent.

Nava Ben-Zvi, Co-Executive Director.
Gilbert Castellan, Academic Team Member.
Richard Thomas, Executive Producer.
Lisa Ragsdale Project Manager.

WS IV.15 SALON V K-6 ED

DASH: DEVELOPMENTAL APPROACHES IN SCIENCE & HEALTH

Participate in a hands-on workshop presenting materials from the new Developmental Approaches to Science and Health (DASH) K-6 project.

Francis M. Pottenger, III, Project Director, DASH, University of Hawaii.

6:30 + PM FOYER OUSIDE OF SALON III

NASTS MEMBER'S RECEPTION

First there was instant liquid N_2 ice-cream. Last year was Ben and Jerry's 1% for Peace "Peace Pops." What will we have this year? At the very least you can expect relaxed conversation with friends and companions. But in addition be ready for an environmentally-sound surprise.

7:30 - 8:30 PM SALON III

"THE NEW COMMUNICATIONS TRIAD: HOW COMPUTING, TELECOMMUNICATIONS AND MEDIA HAVE INTEGRATED FOR THE 1990'S"

Stewart Kranz, Manager of Human Systems Program Development for Customer Services, Digital Equipment Corporation.

DEMONSTRATING STATE OF THE ART TECHNOLOGY

The new communications triad describes in very broad terms the conception and realization, primarily through technological innovation, of an ever more sophisticated communications system which literally transports our thoughts with print (memos, love letters, post cards, stock transfers), our voices (telephones, radio, cassette tapes, CD's), our values (film, fax, television, videotape), and our stifled artifacts of tasting and touching together by jetting computer dispatched California wines, sensuous pearls, intimate undergarments, frozen Tournedos steaks, pigskin baby shoes, and red red roses back and forth around the world electronically hundreds of millions of times each day. In his talk, Dr. Stewart Kranz visualizes how this incredible synthesis took place primarily during the last 40 years. He illustrates for the layman how the communications triad evolved primarily to compensate for the inherent weakness of each discipline.

9:00 - 10:00 PM SALON E

STS NETWORKING DISCUSSION

Come join leaders in STS networking from around the world discuss ideas on designing and using Educational Networks.

Barbara Barchi, Director, National STS Network.
Eda Barbosa, Ministry of Education Brazil, and **Rolando Axt**, Federal University of Rio Grande del Sul, *"The Sub-Program in Education for Science: A Strategic National Network to improve Science Education in Brazil."*

EARLY MORNING SESSIONS

8:00 AM SUNDAY, FEB. 4

8:00 - 8:45 AM

EB 2.1 SALON III

INTERNATIONAL STS REPORT

Find out what is happening in STS around the world. Please come an share your experiences with STS.

George Bugliarello, President Polytechnic University, MODERATOR.
Vitali G. Gorokhov, USSR Academy of Sciences.
Vincente Perez Plaza, Genralitat Valenciana,Spain.
Ubiratian D'Ambrosio, Vice Rector, University of Campinas, Brazil.

Others to be announced

EB 2.2 SALON F

INTELLECTUALS AND SOCIAL RESPONSIBILITY

What is the appropriate role of philosophers and other intellectuals in the effort to promote social responsibility? Does the organization of intellectual activity in academic disciplines promote or constrain this goal?

Leonard J. Waks, STS Program, The Pennsylvania State University.

8:00 - 10:00 AM WORKSHOPS AND ROUNDTABLES

RT V.1 SALON A EDUC

WHAT RESEARCH ON STS SAYS TO THE SCIENCE TEACHER

Glen S. Aikenhead, University of Saskatchewan, *"Student Views on STS Topics in Canada."*
Herbert K. Brunkhorst, California State University - San Bernardino, *"Student Views on STS Topics in the U.S."*
Frans van der Loo, Henk de Jager, The Netherlands, *"Decision Making on Environmental Issues."*
Dennis W. Cheek, New York Science, Technology and Society Education Project, *"Children's Conceptions of the Social Sciences and Social Institutions."*
Ronald Bonnstetter, University of Nebraska, *"Traits of STS Teachers."*
Robert E. Yager, The University of Iowa, *"The Iowa Chautauqua Project."*

Five Domains and STS Affects

Larry H. Myers, Muscatine High School, *"Concept Development and Their Applications."*
William F. McComas, Norristown Area High School, *"The Affective Domain."*
Susan M. Blunck, The University of Iowa, *"Development of Basic Science Process and Creative Skills."*

RT V.2 SALON I K-12 ED

TEACHER FESTIVAL

Join this two hour festival of materials for teachers.

Phyllis Katz, Director, and **Janet Frekko**, Associate Director, Hands On Science Outreach, Inc., *"Hands On Science Outreach."*
Bob Greenberg, 8th Grade Social Studies Instructor, Ravenscroft School, North Carolina, *"Teaching Technological Issues in the Middle School Classroom."*
Marilyn McClain, Chairman - Secondary Gifted Program - Region V, Dade County Schools, Florida, *"The High Tech Summer."*
Richard Wagner, Science Teacher, Wissahickon Senior High School, Pennsylvania, *"Toxicology; An STS Approach."*
Richard A. Methia, Director, Education Department, Challenger Center, *"The Mission Continues: the Challenger Center."*
William Peruzzi, Project Coordinator, and **Dennis W. Cheek**, Coordinator of Curriculum Development, NYSTEP, *"The New York Science, Technology and Society Education Project."*
Mary Lewis Sivertsen, Education Specialist, National Diffusion Network, U.S. Department of Education, *"A Sample of Materials Disseminating through the National Diffusion Network."*

CT V.3 SALON J MINORITY

MINORITY EDUCATION CONFERENCE TABLE

This two hour discussion concerns minority issues in education.

Russell E. David, A.P. Math, Alfred E. Smith High School, Bronx, *"How to Use Computer Spreadsheets in the Classroom to increase Attendance and Decrease Dropouts."*
Paula Getzin, Associate Professor of Chemistry, **John Kmetz**, Assistant Dean, School of Natural Science, Nursing and Mathematics, and **Betty Barber**, Dean, School of Natural Science, Nursing and Mathematics, Kean College of New Jersey, *"SCIENCE STAR and HEALTH EPIC - Successful Summer Bridge Programs for Minority High School Students."*
Lisa Novemsky, Coordinator for Educational Research and Outreach Programs, **Phyllis Boling**, Associate Director, Counseling Center, **Rose Dios**, Associate Chairperson of Mathematics, **Ron Gautreau**, Professor of Physics, **Frieda Zames**, Associate Professor of Mathematics, **Doris Fleischer**, Special Lecturer, Humanities Department, **Howard Kimmel**, Assistant Vice President for Academic Affairs, **Arlene McKenna**, and **Alex Cefalu**, **Isabell Goncalzes** and **Michael Novemsky**, Pugwash International Organizers, Graduate Students, New Jersey Institute of Technology, **Marie Siewierska**, Cooke College, Rutgers and **Jeanne Ginsberg**, Director, Playhouse, Inc., *"Removing the Rose-Colored Glasses."*

CT V.4 SALON V GRAD

GRAD STUDENT CONFERENCE TABLE

Salma Zaki Nashef, Doctorate Student, Middle East Technical University, Ankara,Turkey, *"Effect of Academic Achievement and Selected Biology-Geography Unit Emphasizing the Relationship among STS Upon the Opinions of Secondary Students Toward this Relationship in Jordan."*
Joan M. Carey, Graduate Student, University of Virginia, *"Technological Determinism or Culture Shaping Technology? Insights from China's Computer Classroom."*
Jong-Dall Kim, Graduate Student, University of Delaware, *"Nuclear Determinism in the Republic of Korea."*
Felix Edoho, Graduate Student, University of Delaware,*"Technology Transfer and Third World Development."*
Constantine Hadjilanbrinos, Graduate Student, University of Delaware, *"Politics, Ethics and Nuclear Power."*

CONCURRENT PAPER AND WORKSHOP SESSION - FIVE

9:00 - 10:00 AM **SUNDAY, FEB. 4**

WS V.5 SALON B 5-10 ED

CANCELED

WS V.6 SALON C EDUC

TEACHING STS ISSUES - TWO APPROACHES

This session will focus on a well-researched model for involving students in STS issues. Two approaches for utilizing the model will be presented.

Harold R. Hungerford, Professor of Curriculum & Instruction, Southern Illinois University.
Trudi L. Volk, Lecturer, Southern Illinois University.
John Ramsey, Assistant Professor, University of Houston - Central Campus.

WS V.7 SALON K 9-12 ED

VALUES IN SCHOOL SCIENCE: SOME PRACTICAL MATERIALS AND SUGGESTIONS

A rationale and a sample of field-tested material for introducing societal and ethical issues in conventional science courses without seriously affecting course schedules, preparation time, or budgets.

Richard F. Brinckerhoff, Department of Science, Phillips Exeter Academy.
Dana Zeidler, Associate Professor of Science Education, University of Lowell

WS V.8 SALON F 7-12 ED

TEACHING SCIENCE THROUGH LITERATURE AND SCIENCE

This workshop, sponsored by the Society for Literature and Science (SLS), explores ways of teaching science in grades 7-12 by using popular fiction, especially science fiction.

Lance Schachterle, Chair, Interdisciplinary Studies, Worcester Polytechnic Institute, MODERATOR.
A.D. van Nostrand, Department of English, Georgia Institute of Technology.
Frank Trainor, WPI School-College Collaboration in Math and Science Education, former Elementary School Principal.

AIDS AND STS EDUCATION

Presenters will look at dealing with the issue of AIDS in STS Classroom.

Judith Laurence Pastore, Coordinator Technology, Society and Values Program, University of Lowell, *"Using Literature to Understand AIDS."*
John Lord, Editor-In-Chief, Enterprise for Education, *"AIDS and STS."*

CHEMICALS IN SOCIETY: CHEMICAL EDUCATION FOR COMMUNITY AND THE WORKPLACE

Chemicals in Society materials are designed to present information about chemicals, toxicity, groundwater, risk and other topics to the non-technically trained community and workplace groups.

Mark Koker, CEPUP Teacher Associate, The Chemical Education for Public Understanding Program (CEPUP).

ENVIRONMENT AND STS IN THE CLASSROOM: K-6 GRADES

Presenters will discuss activities and programs they use in the teaching of environmental issues in the elementary classroom.

Raymona O'Brien, Primary Teacher, Bristol Elementary School, and **Patricia Pierce**, 4/5 Teacher, Mountain Street Elementary School, Vermont, *"The Great Garbage Sort and the Million Year Picnic."*
Erik Mollenhauer, Project Director, University of Delaware *"The Gypsy Moth in the Classroom."*
Dale Westcott, K-12 Science Supervisor, and **Barbara Westcott**, Grade 5 teacher, Guilderland Schools, *"Backyard Acid Rain Kit (BARK) Project."*
Reginald Hopkins, and **Linda Willey**, students, WPI, *"From Oxidation to Air Pollution: S-STS for Early Elementary Students."*

CS V.12 LEE ROOM ENVIR ED

ENVIRONMENT AND STS IN THE CLASSROOM: 7-12 GRADES

Presenters will discuss activities and programs they use in the teaching of environmental issues in the secondary classroom.

Nadine Butcher, Eighth Grade Earth Science Teacher, Parkway East Junior High School, Missouri, *"Creative Environmental Dramatic Opportunity."*
Teny Topalian, Assistant Professor of Science Education, California State University, Long Beach, *"Science, Technology and the Marine Environment."*
Marcia Woodroffe, Teacher - Biology and Physical Science, Morristown-Hamblen High School West, Tennessee, *"Asbestos: Today's Number One Environmental Project."*

CONCURRENT PAPER AND WORKSHOP SESSION - FIVE

9:00 - 10:00 AM SUNDAY, FEB. 4

CS V.13 SALON E SNS

THE STS EXPERIENCE: IONA COLLEGE

Panelists from IONA College will show what initiatives they have used to implement STS across the disciplines.

Warren Rosenberg, Associate Professor of Biology, IONA College, *"Assessing Technology in Electrical Applications: A Curriculum Module."*
Nicolyn J. Ausiello, Director of Laboratory Operations, IONA College, *"Assessing Genetic Biotechnologies: A Curriculum Module."*
Victor A. Stanionis, Curriculum Director, Scientific and Technological Literacy Program, IONA College, *"An STS Course for Business Students."*
Ming Huang, Associate Professor, IONA College, *"Business Forecasting Beyond Spread Sheet."*

CS V.14 MADISON ROOM COLL ED

ENGINEERING ETHICS AND THE EXPERT IN THE COLLEGE CLASSROOM

Presenters will examine engineering ethics classes and their role in the overall college experience.

William D. Rifkin, Graduate Fellow, VTSS, Stanford University, *"Whom to Heed in the Expert Society: A Course for Colleges and Universities."*
John Opie, and **Norbert Elliot**, STS Program, New Jersey Institute of Technology, *"The Challenger Disaster, O-Rings, Morton Thoikol, and Roger Boisjoly: A classroom case study in STS and 'the Human factor'."*
John Opie, John E. O'Connor and **Norbert Elliot**, STS Program, New Jersey Institute of Technology, *"Integrating Ethics in the Engineering Curriculum: An Innovative Collaboration between Engineering, STS and the Humanities."*

CT V.15 JEFFERSON ROOM COMPU

COMPUTERS IN THE CLASSROOM

Join a discussion on various software packages and the application of computers in the classroom.

P.S. di Virgilio, Center for Advanced Technology, Canada, *"A CASE for Multicultural Education: Developing Flexible Tools For the Interactive Tutoring System."*
Robert Novak, Associate Professor of Physics, Iona College, *"Computer Applications in Teaching Environmental Science."*
Susan Mattson, Interactive Courseware Developer, Florida State University/IMS Project, *"The Interactive Media Science Project."*
Rae C. Schipke, English Department, University of Southern Mississippi, *"Learning Styles, Personality Types, and the Electronic Collaborative Writing Classroom: Characteristics of Successful Students."*

CS V.16 SALON II BIO-MED

THREE THEMES IN BIOTECHNOLOGY

Presenters will examine various issues in biotechnology.

Brian R. Shmaefsky, Chair, Biology Department, Northwestern Oklahoma State University, *"Public Attitudes Toward Human Genetic Manipulation; A Revitalization of Eugenics?"*
Donna M. Hughes, Lecturer, Women's Studies Program, Penn State University, *"Including Social Issues in the Teaching of Human Biology."*
Carl E. Brunner, Associate Dean, College of Liberal Arts and Sciences, Kutztown University, *"Plant Germplasm Conservation: A Global Imperative."*

CS V.17- SALON G DEVEL

THE ECONOMIC AND ETHICAL CONSIDERATIONS OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT ON AFRICA AND AFRICAN DIASPORA

This panel will focus on the economic and ethical implications of scientific and technological developments in the 21st century on Africans and those of African ancestry. The discussion will include the ways in which Africans juxtapose moral and spiritual issues with Western modernity.

Ron Potter, Associate Director, Essex County College Chapter I Program, Newark, New Jersey.
Linda Quander, Chairperson and Associate Professor of Communication, Clark Atlanta University, MODERATOR.
Sekazi Mtingwa, Research Scientist, Argonne National Laboratory.

CONCURRENT PAPER AND WORKSHOP SESSION - SIX

10:15 - 11:15 AM **SUNDAY, FEB. 4**

WS VI.1 SALON A K-6 ED

USING CHILDREN'S LITERATURE TO DEVELOP STS UNITS

Dr. Seuss' Bartholomew helps participants solve a common urban problem: Who is responsible for choosing and mobilizing effective machinery for storm clean-ups?

Constance H. Gordon, Associate Professor, Trinity College.

CS VI.2 SALON B 5-8 ED

MIDDLE SCHOOL SCIENCE CURRICULA: NEW PROJECTS, NEW GOALS

The three projects represented in this panel are currently developing curriculum materials for middle school. Each is unique in its approach and focus. The rationales underlying the different approaches will be explained with audience questions and critique invited.

William Peruzzi, Project Coordinator, New York STS Education Project, NY State Education Department.
Janet Powell, Project Director, Science and Technology: Investigating Human Dimensions (BSCS).
George Dawson, Project Director, Florida State University, Interactive Media Science Project.
Dianne Robinson, Hampton University, MODERATOR.

WS VI.3 SALON C 9-12 ED

DEVELOPING STS CLASSROOM ACTIVITIES

New ideas and techniques for developing hands-on activities that include equal parts of science, technology and societal concerns by educators who have been doing it for ten years.

Minaruth Galey, University of Colorado-Denver.
Paul Bell, Pennsylvania State University.
E.J.Piel, Retired, SUNY at Stony Brook.
Randy Weisenmeyer, Lock Haven University.

CT VI.4 LEE ROOM COLL ED

COLLEGE AND UNIVERSITY STS PROGRAMS AND COURSES CONFERENCE TABLE

Presenters will discuss how their various institutions have initiated STS courses and programs.

James R. Philips, Math/Science Division, Babson College, *"Core Courses for Business Students."*
Earl D. Hanson, Visiting Professor of Science and Human Values, Lewis and Clark College, *"Scientific Literacy and Liberal Learning: An STS Approach."*
Barbara Anne Radtke, Instructor, Religious Studies, Emmanuel College, *"Women in a Technology World: An Interdisciplinary Core Course."*
Martin L. Sage, Director, Technology and Public Affairs Program, Syracuse University, *"Technology: An Addition to the Science Curriculum."*

CS VI.5 SALON J ENVIR

GLOBAL CLIMATE CHANGE: MULTIPLE PERSPECTIVES

The global climate issue will be discussed from multiple points-of-view. What we know about global climate change and what we do not know about the issue will be presented.

Patrica A. Cunniff, Professor of Chemistry, Prince Georges Community College, *"Global Climate Change from an Educational Viewpoint,"* MODERATOR.
Jana Oakley, Assistant Vice President, National Association of Manufacturers, and Global Climate Coalition, *"The Global Climate Change Issue from an Industrial Perspective."*
Kathleen A. Ream, Head, Department of Government Relations and Science Policy, American Chemical Society, *"Global Climate Change from a Scientific Society's Viewpoint."*

WS VI.6 SALON I K-12 ED

POPULATION EDUCATION: TEACHING FOR A SUSTAINABLE FUTURE

Hands-on activities to help students understand population growth, its environmental and social impacts, and ways everyone can contribute to a sustainable world. Free Materials!

Deborah Brouse, Director of Population Education, Zero Population Growth, Inc.

WS VI.7 MADISON ROOM K-12 ED

GRASSROOTS CURRICULUM IN BIOTECHNOLOGY

Elementary and secondary classroom teachers work with other educators to write, implement and evaluate a Biotechnology unit. Jointly sponsored by business and education.

Margaret Burd Powell, Chair, Education Department, Principia College.
Sarah F. Perkins, Associate Dean and Biology Professor, Principia College.

CS VI.8 SALON H ENVIR ED

ENVIRONMENTAL EDUCATION IN THE CLASSROOM

Participants will be shown two different approaches to Environmental Education, one from New York City and the other from the Netherlands.

Michael Zamm, Director, Environmental Education, Council on the Environment of New York City, "Youth Participation Concerning Environmental Issues: Training Student Organizers."
Henk de Jager and **Frans van der Loo**, Centre for Science and Mathematics Education, University of Utrecht, The Netherlands, *"Fuel Consumption: A Burning Problem for the Environment."*

CONCURRENT PAPER AND WORKSHOP SESSION - SIX

10:15 - 11:15 AM SUNDAY, FEB. 4

WS VI.9 SALON K WORK

TOWARD AN ECOLOGY OF TECHNOLOGY FOR ENGINEERS

This workshop will present and discuss a new frontier in engineering education. By setting out certain theoretical principles and working them out in a set of courses, the workshop will seek to share and discuss this kind of strategy.

Bill Vanderberg, Director, Centre for Technology and Social Development, University of Toronto.

CS VI.10 SALON E EDUC

VALUES AND ETHICS IN THE CLASSROOM

Presenters will discuss how values and ethics are curently being presented to students and possible ways they should be presented.

Uri Zoller, Department of Science, Haifa University, Israel, *"The Ethical Issue in STS Education: Students' Versus Their Teachers' Position on STS-Related Issues."*
Gerard M. Fourez, Director, Department of Sciences-Philosophies-Societies, University of Namur, Belgium, *"How to Trace Values and Ideologies in Science Teaching."*
Dennis M. Travis, Dean, School of the Natural Sciences, New York Institute of Technology, *"Making Ethical Decisions using Scientific Values."*

CS VI.11 SALON G NETWK

METRO NYC STS SUPPORT GROUP

The Metro NYC Support Group, currently in formation, will conduct an open forum to provide teachers of all disciplines and levels with an opportunity to become acquainted and establish a basis for mutual support activities.

Gary Beneson, Associate Professor, City College of New York, MODERATOR.

CS VI.12 JACKSON ROOM PERSP

FROM SUPERMAN TO GEEK AND BACK: MODELS OF SOCIETAL CHANGE FOR A POST-INDUSTRIAL CULTURE

Presenters will examine the process of change within our post-industrial technological society.

David K. Vaughan, Department of Communication and Organizational Sciences, Air Force Institute of Technology, *"The Image of the Engineer in the Popular Imagination, 1880-1980."*
James R. Gray, Director of Technical Services Institute, Northern Kentucky University, *"Technology Transformation."*
Robert E. Baker, Director of Liberal Arts, North Shore Community College, *"Visceral Change: Mythos and Hope."*

CS VI.13 SALON II PERSP

THREE STS VIEWS OF EXPANDING HUMAN CONSCIOUSNESS

Presenters will explore the role of expanding human consciousness on the future of humankind.

Mario Kamenetzky, Independent Scholar, *"Expansion of Consciousness as an Educational Tool."*
Jerome C. Glenn, Executive Director, The American Council of the United Nations University, *"Future Inter-Relationship of Mind-Body-Technology."*
Sofia Kamenetzky, M.D., and **Janet Smith**, Consumer Health Strategies, *"Rethinking Health in the Classroom."*

CS VI.14 JEFFERSON ROOM COMPU

TO BE A HIGH TECH CLASSROOM OR NOT TO BE?

Presenters give different multi-perspectives on the issue of the use of educational technology in the classroom.

Daniel J. Brovey, Director, and **Irene Brovey**, Associate, Office of Technology, Queens College, "A Technology-Enhanced Classroom: What it really looks like."
Bruce Katz, Principal, **Leigh Worthing**, Computer Technology Coordinator, and **Ernestine Terrell**, Science Teacher, Eugene Burroughs Middle School, *"A Vision of the Future."*
Randall G. Nichols, Assistant Professor, University of Cincinnati, *"Alternatives to a Destructive Educational Technology."*

CS VI.15 SALON F EDUC

THE EDUCATION DILEMMA: THE DEMOGRAPHICS OF MATH, SCIENCE AND JOBS

Participants will be given the demographical information concerning science, math and technical education and its relation to getting a job.

Susan E. Pickerell, Research Associate, Oak Ridge Associated Universities, *"Needs Assessment of Secondary Science and Mathematics Education."*
Lillian Robbins, Professor of Psychology, Director, College Honors Program, Rutgers University, and **Judith S. Weis**, Program Director, Undergraduate Office, NSF, *"Careers in Science: Gender and Cohort Differences."*

CS VI.16 SALON V WOMEN

WOMEN, SCIENCE AND TECHNOLOGY AT THE UNIVERSITY

Participants will discuss university courses specially geared to Women. This session will also look at the reaction of students to the murdering of the women engineers in Montreal and its implications to Women in a science and technology world.

Joyce J. Contrucci, Assistant Professor of Psychology, and **Britta Fischer**, Associate Professor of Sociology, Emmanuel College, *"Women and Technology at a Liberal Arts College."*
Karen Messing, University of Quebec, Montreal, *"Teaching about Science, Technology, Men and Women."*

SEE NEXT PAGE FOR SESSION CS VI.17

CSVI.17 _SALON VI ENGLISH

INTRODUCING STS INTO HUMANITIES CLASSES

Draws on a workshop from last summer at Tufts University, "Technology in American Society," to illustrate how literature and history are rich resources to introduce students to the impact of technology on society.

Rita Yeasted, LaRoche College.

CLOSING PLENARY

11:30 - 1:00 PM

SALON III

Theme III

EARTH DAY 1990: GLOBAL CLIMATE CHANGE

This is the continuation of the tradition started last year having a plenary sponsored by the World Watch Institute, the foremost environmental research institute in the country. This year the talk will focus on water.

MAIN SPEAKER: **SANDRA POSTEL**, Vice President, World Watch Institute.

"THE SHAPE OF A SUSTAINABLE SOCIETY"

CLOSING COMMENTS: **Carolyn Graham**, New NASTS President.
Stephen Cutcliffe, the Newly-Elected NASTS Vice President.

CONFERENCE INFORMATION

Conference staff will try to answer questions and handle all conference related and delegate problems. Staff can be found at the conference registration desk and will be wearing staff ribbons on their nametags.

REGISTRATION DESK HOURS

Thursday:	5:30 pm - 9:30 pm
Friday:	7:30 am - 6:00 pm
Saturday:	7:30 am - 6:00 pm
Sun day:	7:30 am - noon

LOST AND FOUND

Any lost and found items should be turned in to the conference registration desk.

ANNOUNCEMENT AND MESSAGE BOARDS

Announcement boards can be found in strategic locations in the foyers. Please check for program changes and special announcements.

INFORMATION MARKETPLACE

Public Interest Organizations will have tables to display materials and show audio-visual presentations of their work.
Representatives will be available to answer questions.

Socially Conscious Corporations will have tables to display reports, materials and audio-visual presentations dealing with their community and educational involvement.

Representatives will be present to discuss their activities.

See Friday noon to 2:00 pm for more details.

SPECIAL SERVICES CENTER

Local coordination, exhibit area and information market place are being provided by Special Services Center, a non-profit organization based in Arlington, Virginia.

Ellie Kibrick, Director.
Stephen E. Beltz, Associate Director.
William Rolph, Associate Director.

LOGISTICS AND OTHER IMPORTANT INFORMATION

EXHIBITS

There will be staffed exhibits by co-sponsors, educational non-profit organizations, educational service and products companies, science teacher training programs, corporations, and public interest organizations.

Hours: Friday & Saturday 10:00 am - 8:00 pm
Sunday 9:00 am - noon

Location: Foyers surrounding Grand and Arlington Ballrooms.

American Association for the Advancement of Science (AAAS)

American Nuclear Society

American Society for Engineering Education (ASEE)

American Forum: Education in a Global Age

Buhl Science Center, Pittsburgh

Bullfrog Films

Bureau of Land Management/Division of Planning & Environmental Coordination

Center for Social Technology and Values, University of Waterloo, Ontario

Council on Plastics & Packaging in the Environment

Earth Care Paper, Inc.

Earth Day

Edison Electric Institute/Energy Educational Services

Eleanor Rossevelt High School/Science and Technology Program, Maryland.

ERIC Clearinghouse for Science, Mathematics & Environmental Education

ESE Instruments

Fossil Fuels Policy Action

Global Tomorrow Coalition

Greenhouse Crisis Foundation

History of Science Society

Hawkhill Associates

International Electronic & Electrical Engineers (IEEE)/ Society on Social Implications of Technology

International Society for Technology Education (ISTE)

International Society for Technology Education/ Technology Link

Kidsnet

National Academy Press

National AIDS Information Clearinghouse (NAIC)

National Council of Teachers of English (NCTE)

National Geographic Society

National Oceanic & Atmospheric Administration, Central Library

National School Boards Association (NSBA)

National Science Foundation (NSF)

National Science Teachers Association (NSTA)

National STS Network

National Urban Coalition

New Jersey Institute of Technology/Center for Technology Studies

Newsweek Educational Services

Office of Technology Assessment (OTA)

Oxon High School/Science and Technology Center, Maryland

Penn State University/Nutrition Center

Pergamon Press

Pocono Environmental Education Center

St. Martins Press

Science & Engineering Apprenticeship Program (SEAP)

Science Applications International Corporation (SAIC)/ Department of Energy

Scinet

Slideshow Graphics/Environmental Protection Agency, Office of Global Change

Smithsonian Environmental Research Center

Student Pugwash USA

Social Issues Resources Series (SIRS)

Thomas Jefferson High School for Science and Technology, Virginia

Union of Concerned Scientists (UCS)

U.S. Forest Service, Regional HQ, Radnor, Pennsylvania

John Wiley & Sons Canada Ltd.

Zero Population Growth (ZPG)

SPECIAL EXHIBITS AND INFORMATION AREA

There will be a section of exhibits by several programs and organizations not attending the conference. This section is designed and managed by Special Service Center.

Hours: same as regular exhibits above.
Location: SALON D

CONFERENCE EVALUATION SHEET

FOLD AND TEAR HERE

FILL OUT AND RETURN TO BOXES LABELED "TLC-5 EVALUATIONS"

1. With which one sector do you most closely affiliate?

___ Science and Engineering
___ Print and Broadcast
___ Public Interest Sector
___ K-12 Education
___ Post Secondary Education
___ Informal Education
___ Values, Ethics, Religion
___ S/T Policy
___ International STS

2. What did you like best about the Conference?

3. What one aspect would you most like to see improved next year?

4. What topics would you most like to have covered next year?

5. Who would you like to hear address the Conference next year?

6. Is there some way you would like to participate next year?
(include your name and phone number here, or contact us)

7. What was your reaction to
   a. Teacher Festival:
   b. Exhibitors:
   c. Information Marketplace:

8. Do you have any suggestions for vendors/exhibitors for next year?

9. Do you have any comments on the format of the
   a. Call for Participation:
   b. Main Conference Brochure:
   c. Conference Program:

10. Do you have any other comments or suggestions?

11. NASTS has been conducting a nationwide survey of STS programs and initiatives. If you have not already sent us information, can you identify contacts for these to whom we should send a blank survey?

Name:	Institution:	Location:

END

U.S. Dept. of Education

Office of Education
Research and
Improvement (OERI)

ERIC

Date Filmed

March 29, 1991